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Huang et al.

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(54) **METHOD AND SYSTEM FOR EDGE NETWORK EXPOSURE FUNCTION WITH MEC NETWORK**

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H04W 48/16 (2009.01)

(52) **U.S. Cl.**
CPC ***H04W 28/0289*** (2013.01); ***H04W 48/16*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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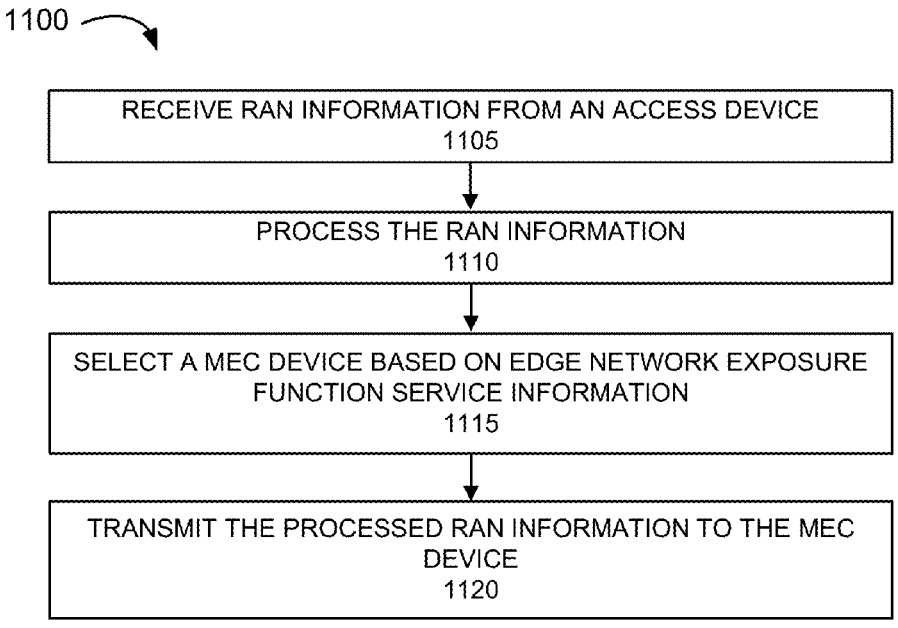
Primary Examiner — Srinivasa R Reddivalam

(57) **ABSTRACT**

A method, a device, and a non-transitory storage medium are described in which a edge network exposure function service is provided. An edge network exposure function device may provide the edge network exposure function service. The edge network exposure function service may communicate with a radio access network, a mobile edge computing network, and a main edge network exposure function device to provide radio access network, end device, and control information. The edge network exposure function device may also facilitate handovers of an end device between mobile edge computing networks. The edge network exposure function device may be situated at the network edge and the main network exposure function device may be situated in a core network.

20 Claims, 15 Drawing Sheets



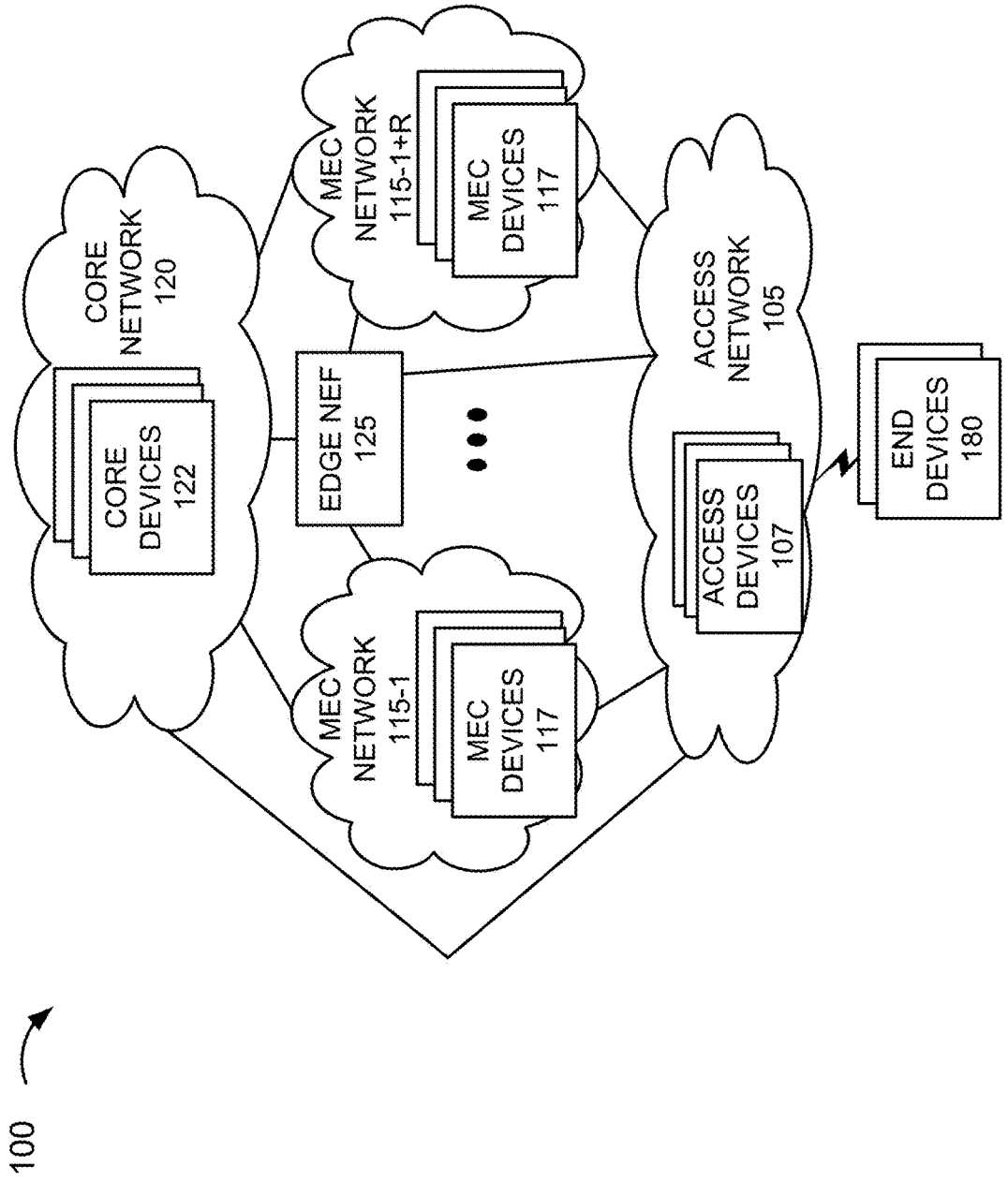

100
CORE NETWORK 120
CORE DEVICES 122
EDGE NEF 125
MEC NETWORK 115-1+R
MEC DEVICES 117
MEC NETWORK 115-1
MEC DEVICES 117
ACCESS NETWORK 105
ACCESS DEVICES 107
END DEVICES 180

Fig. 1

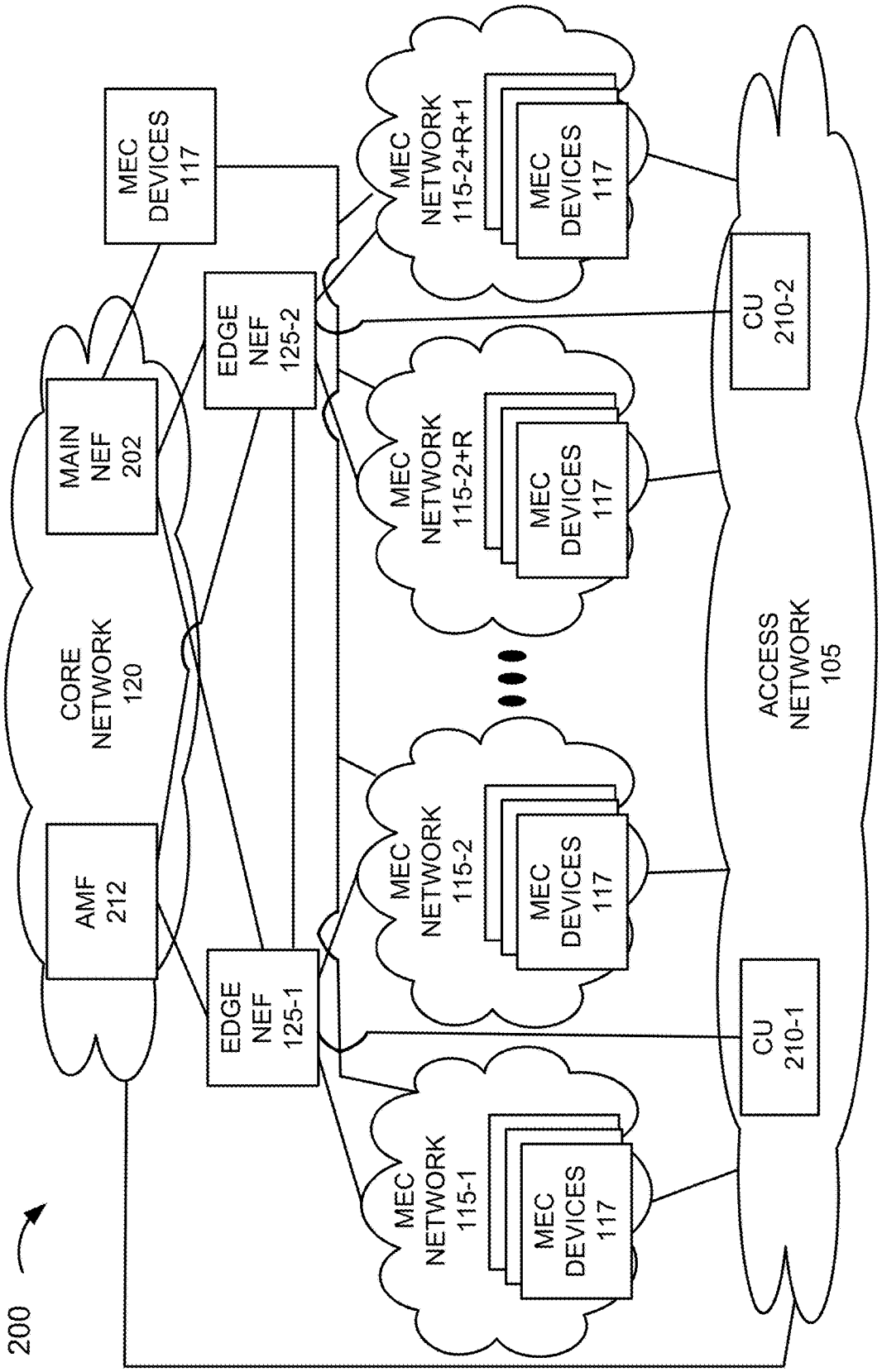
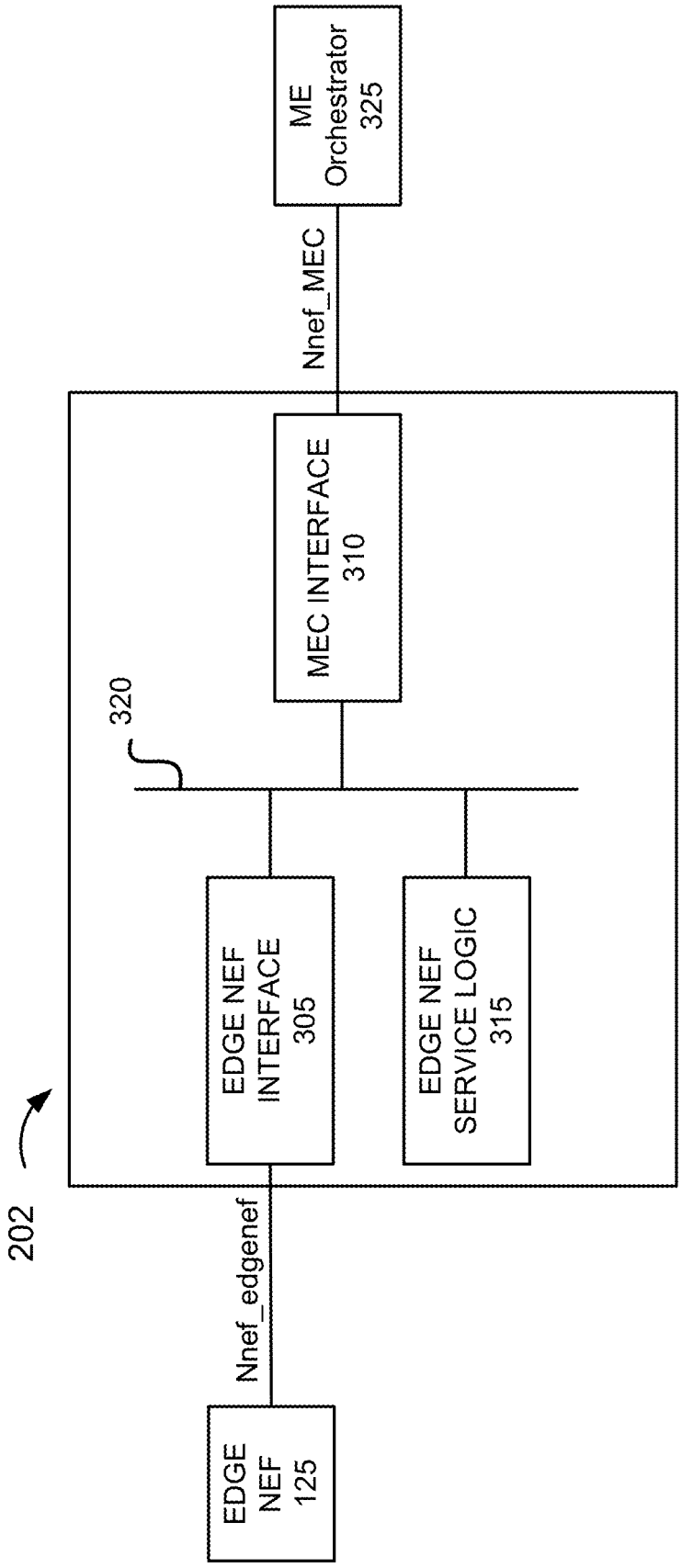

200
CORE NETWORK 120
MAIN NEF 202
AMF 212
MEC DEVICES 117
EDGE NEF 125-2
EDGE NEF 125-1
MEC NETWORK 115-2+R+1
MEC NETWORK 115-2+R
MEC NETWORK 115-2
MEC NETWORK 115-1
ACCESS NETWORK 105
CU 210-2
CU 210-1

Fig. 2


ME Orchestrator 325
Nnef_MEC
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320
EDGE NEF INTERFACE 305
EDGE NEF SERVICE LOGIC 315
202
Nnef_edgenef
EDGE NEF 125

Fig. 3A

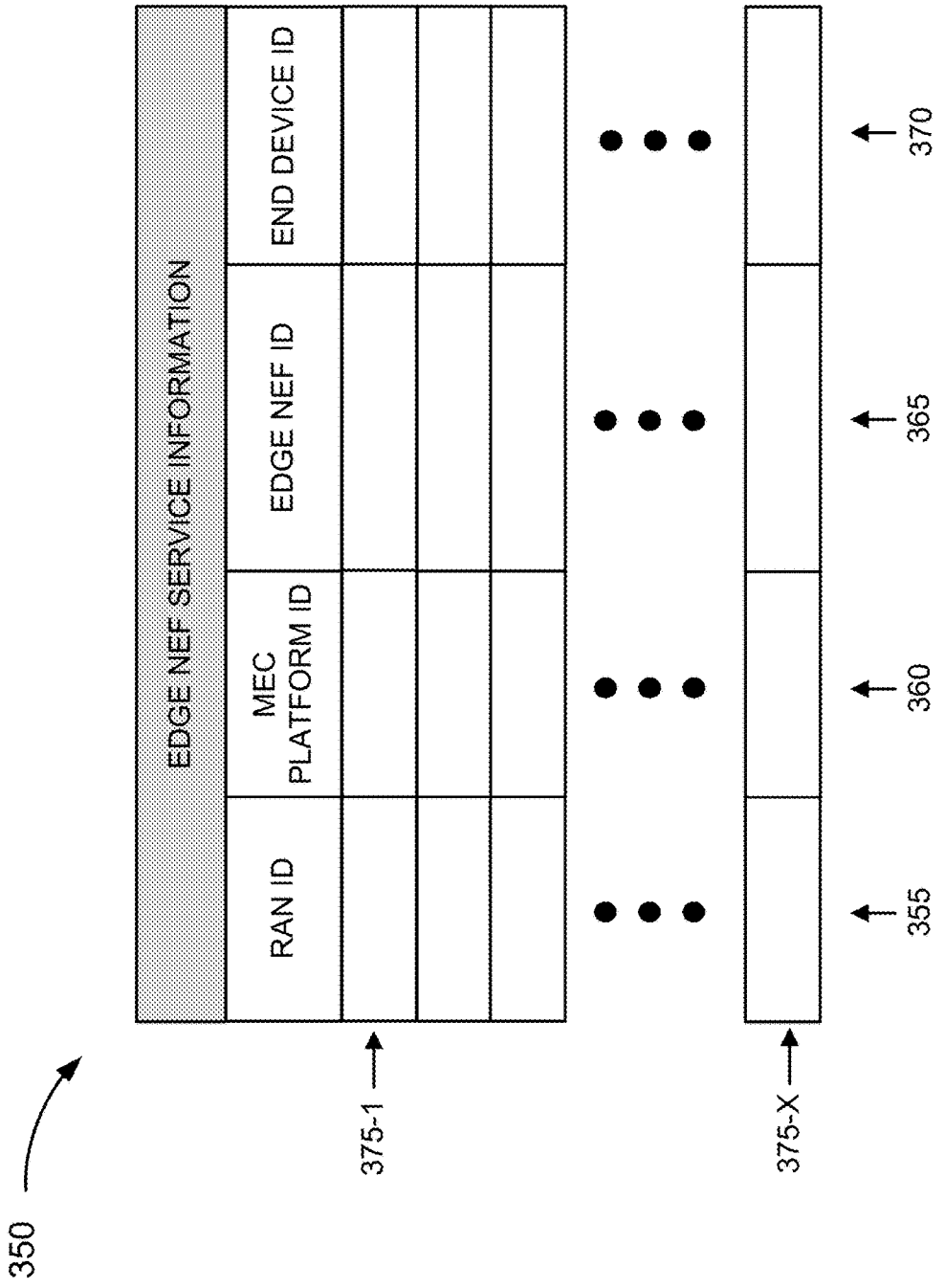
350
EDGE NEF SERVICE INFORMATION
RAN ID
MEC PLATFORM ID
EDGE NEF ID
END DEVICE ID
375-1
375-X
355
360
365
370

Fig. 3B

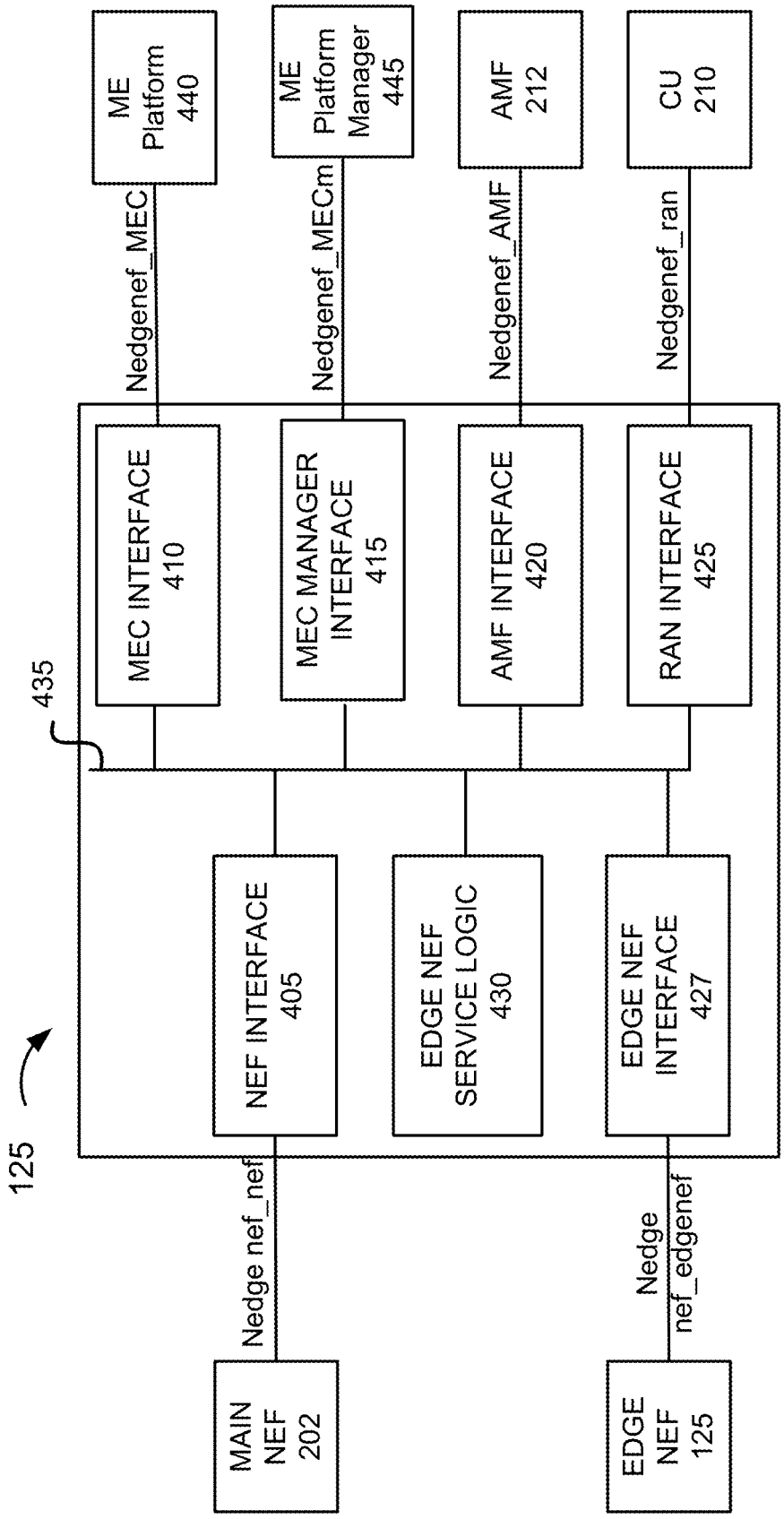
ME Platform 440
ME Platform Manager 445
AMF 212
CU 210
Nedgenef_MEC
Nedgenef_MECm
Nedgenef_AMF
Nedgenef_ran
MEC INTERFACE 410
MEC MANAGER INTERFACE 415
AMF INTERFACE 420
RAN INTERFACE 425
435
NEF INTERFACE 405
EDGE NEF SERVICE LOGIC 430
EDGE NEF INTERFACE 427
125
Nedge nef_nef
Nedge nef_edgenef
MAIN NEF 202
EDGE NEF 125

Fig. 4A

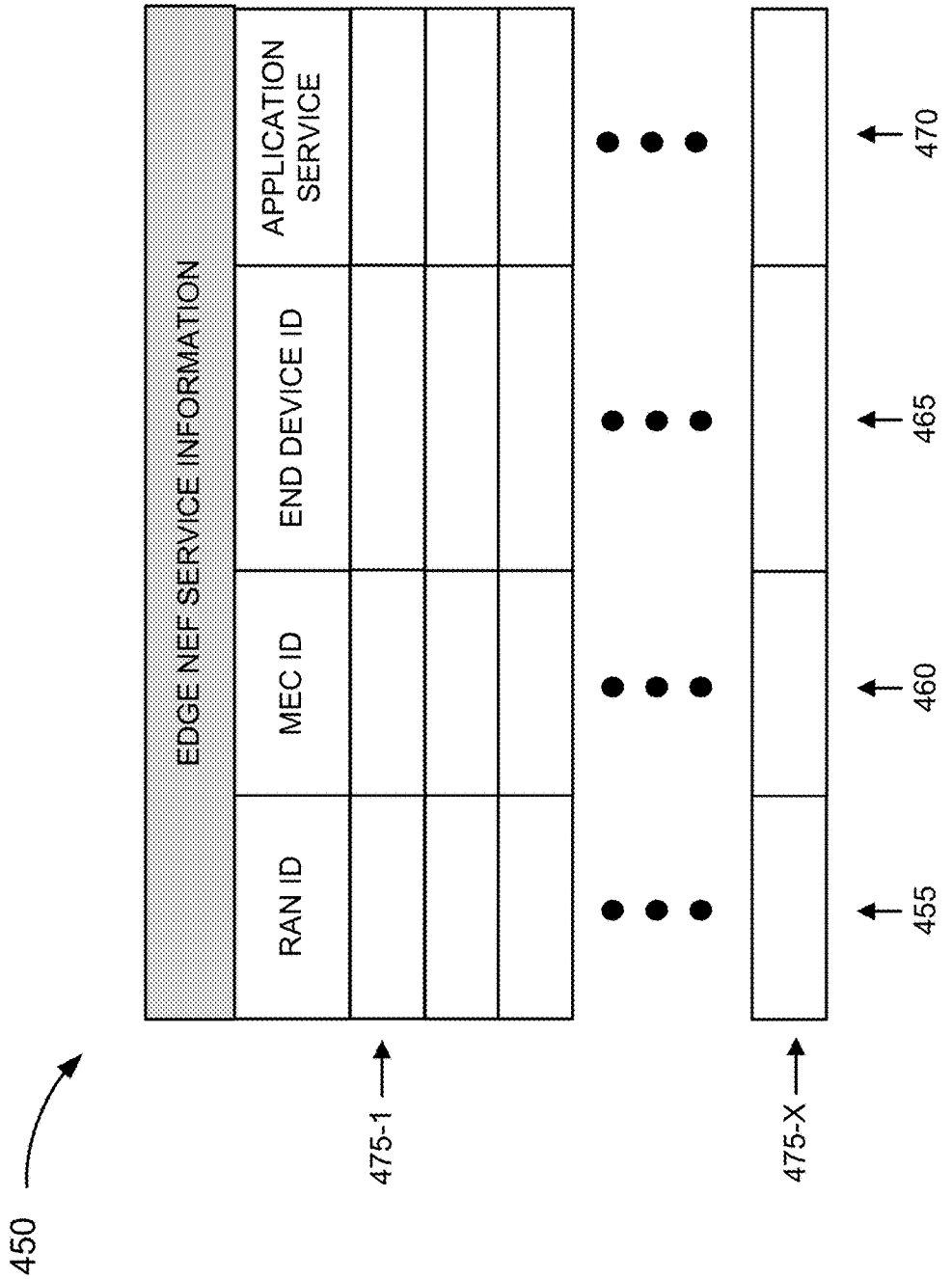
450
EDGE NEF SERVICE INFORMATION
RAN ID
MEC ID
END DEVICE ID
APPLICATION SERVICE
475-1
475-X
455
460
465
470

Fig. 4B

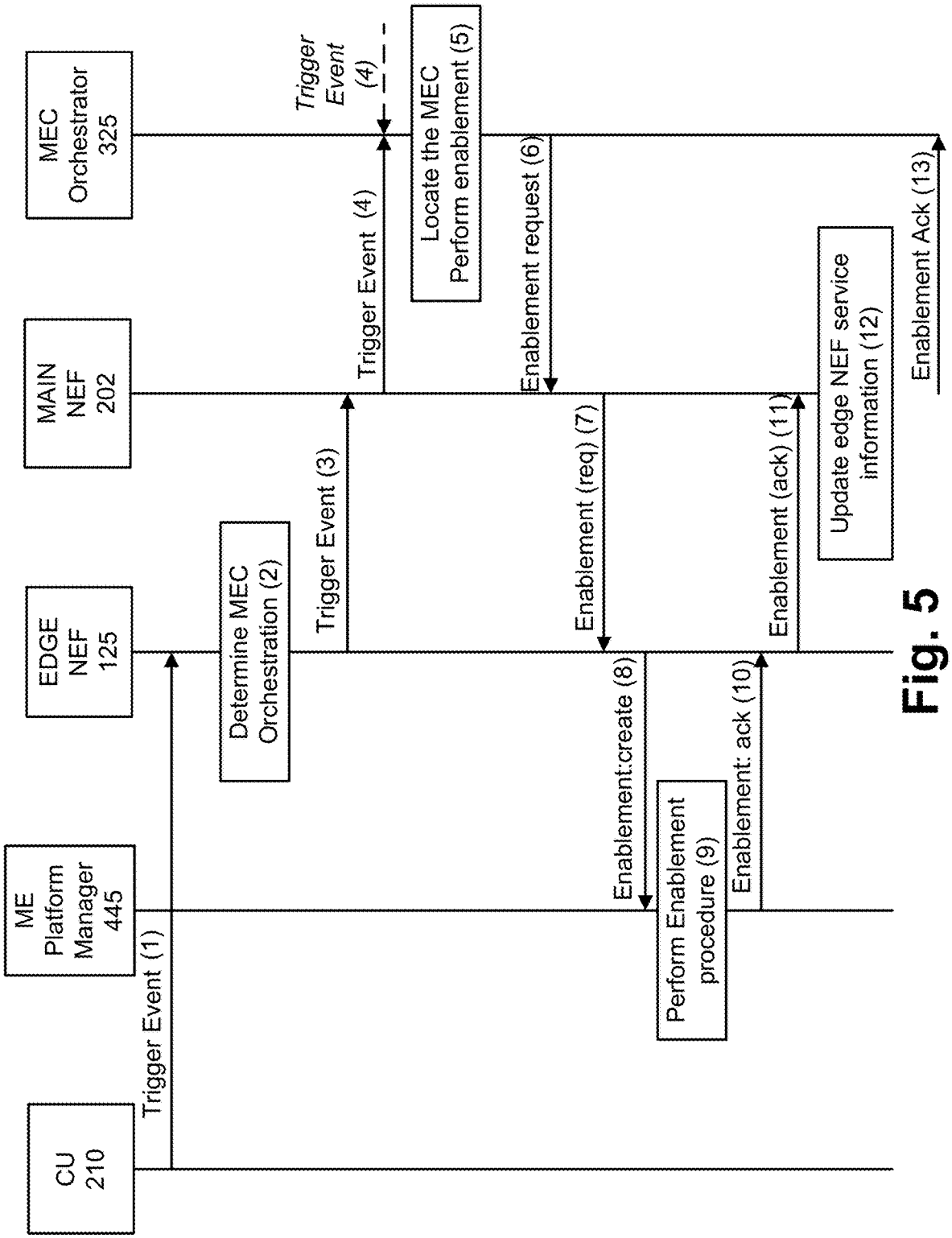
CU 210
ME Platform Manager 445
EDGE NEF 125
MAIN NEF 202
MEC Orchestrator 325
Trigger Event (1)
Determine MEC Orchestration (2)
Trigger Event (3)
Trigger Event (4)
Trigger Event (4)
Locate the MEC Perform enablement (5)
Enablement request (6)
Enablement (req) (7)
Enablement:create (8)
Perform Enablement procedure (9)
Enablement: ack (10)
Enablement (ack) (11)
Update edge NEF service information (12)
Enablement Ack (13)

Fig. 5

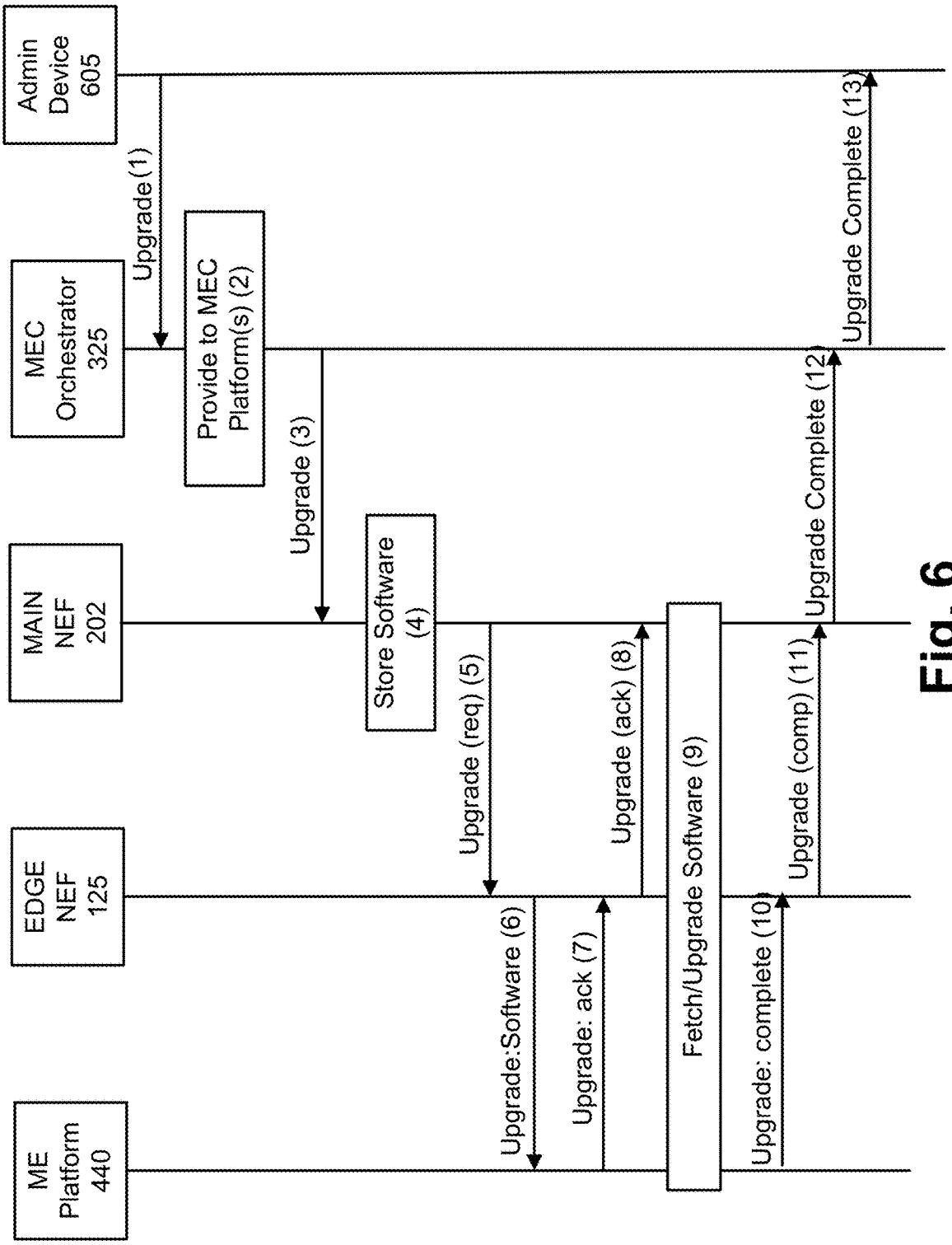
Admin Device 605
MEC Orchestrator 325
MAIN NEF 202
EDGE NEF 125
ME Platform 440
Upgrade (1)
Provide to MEC Platform(s) (2)
Upgrade (3)
Store Software (4)
Upgrade (req) (5)
Upgrade:Software (6)
Upgrade: ack (7)
Upgrade (ack) (8)
Fetch/Upgrade Software (9)
Upgrade: complete (10)
Upgrade (comp) (11)
Upgrade Complete (12)
Upgrade Complete (13)

Fig. 6

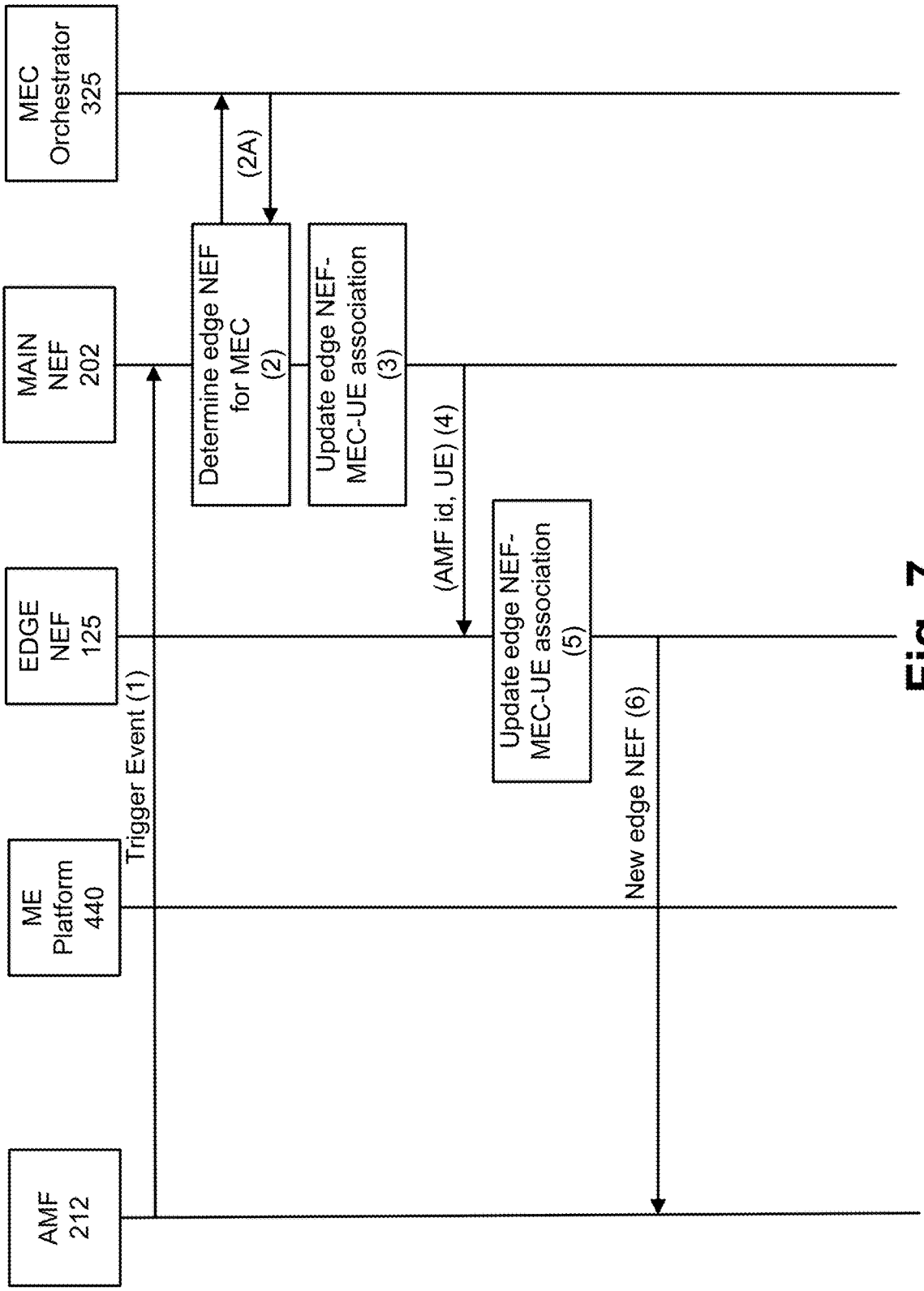
MEC Orchestrator 325
MAIN NEF 202
EDGE NEF 125
ME Platform 440
AMF 212
(2A)
Determine edge NEF for MEC (2)
Update edge NEF-MEC-UE association (3)
(AMF id, UE) (4)
Update edge NEF-MEC-UE association (5)
Trigger Event (1)
New edge NEF (6)

Fig. 7

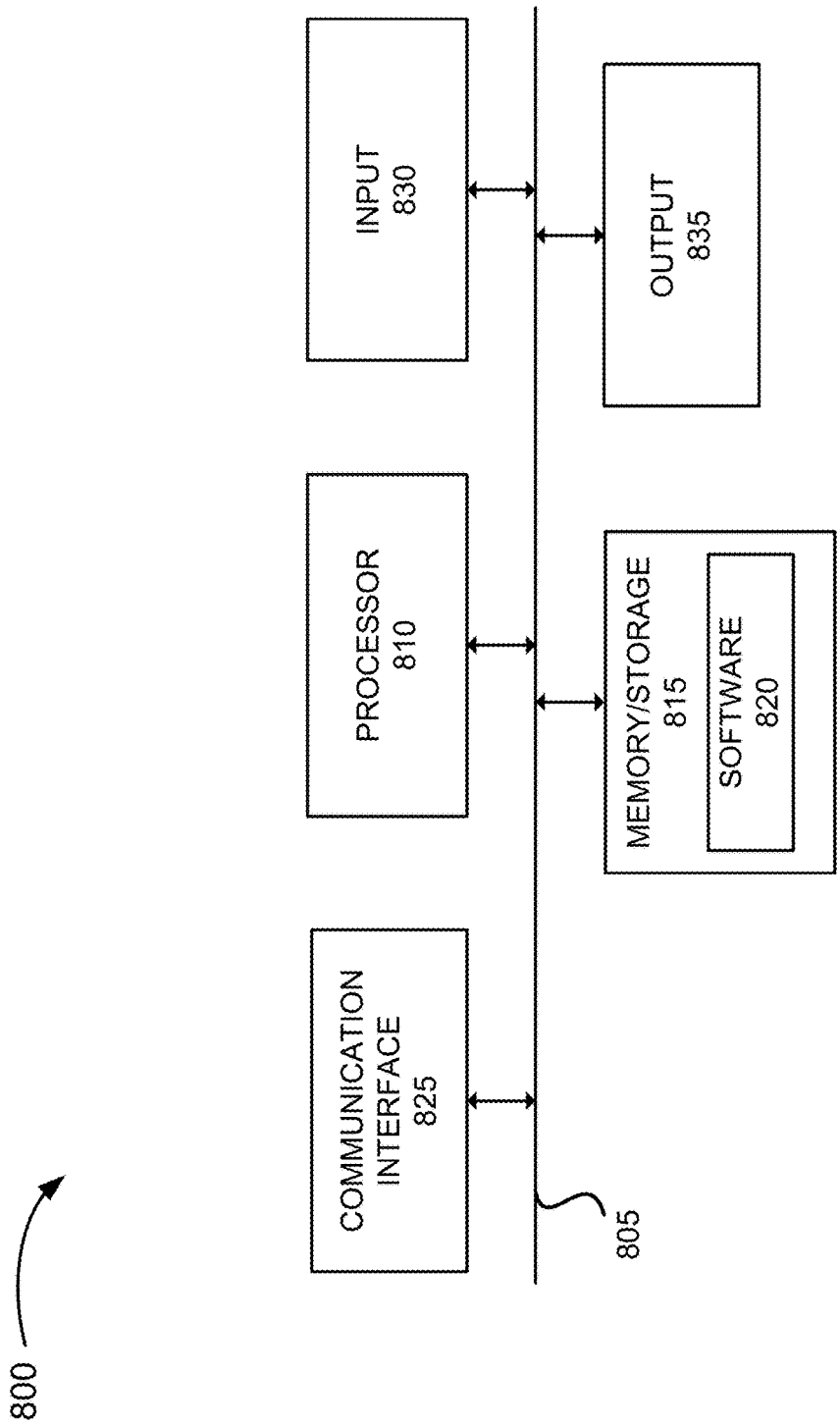
800
805
COMMUNICATION INTERFACE 825
PROCESSOR 810
INPUT 830
MEMORY/STORAGE 815
SOFTWARE 820
OUTPUT 835

Fig. 8

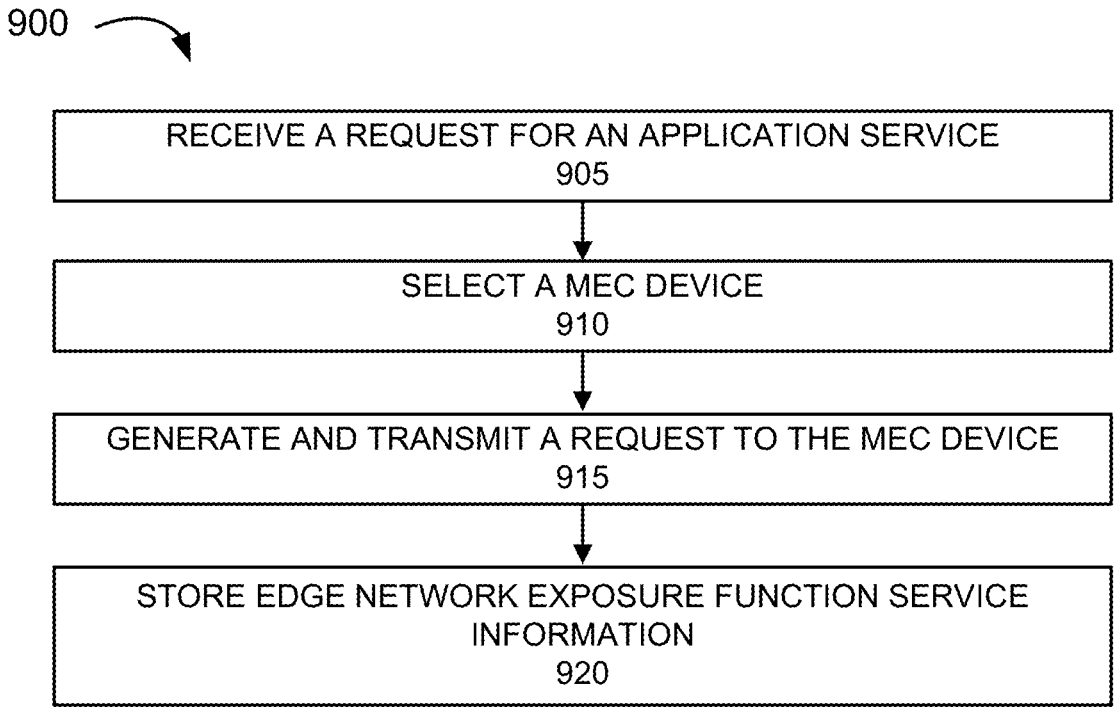
900
RECEIVE A REQUEST FOR AN APPLICATION SERVICE
905
SELECT A MEC DEVICE
910
GENERATE AND TRANSMIT A REQUEST TO THE MEC DEVICE
915
STORE EDGE NETWORK EXPOSURE FUNCTION SERVICE INFORMATION
920

Fig. 9

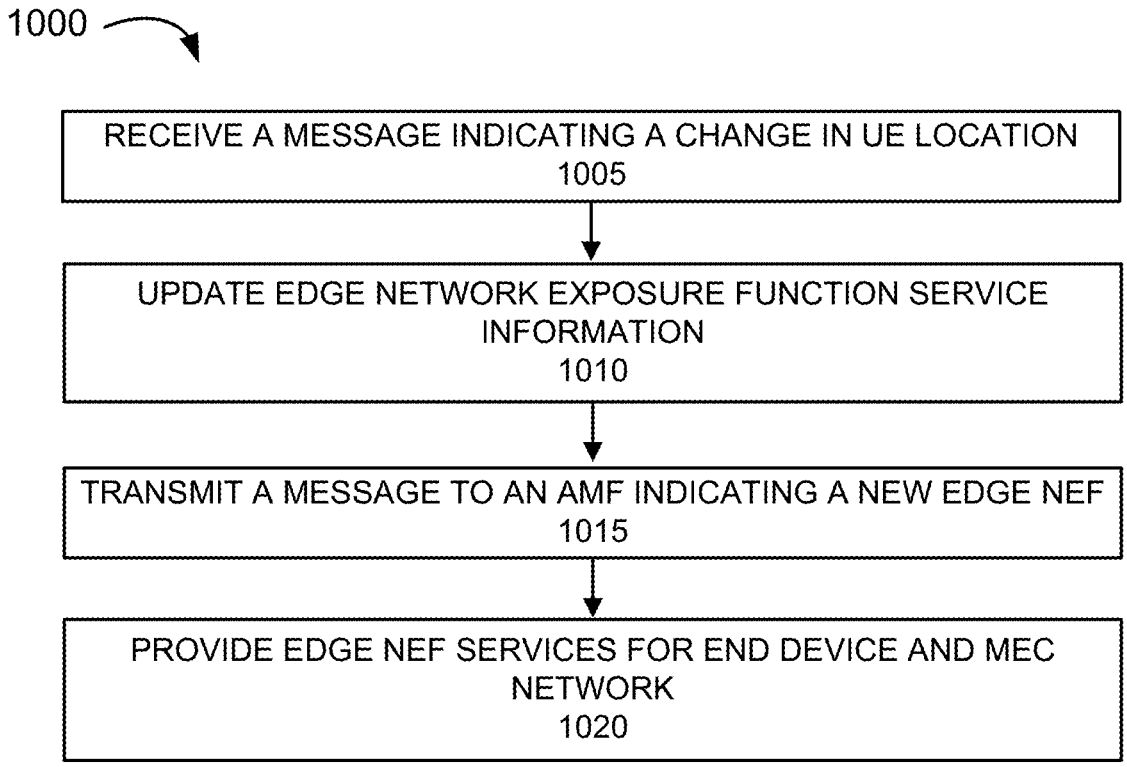
1000
RECEIVE A MESSAGE INDICATING A CHANGE IN UE LOCATION
1005
UPDATE EDGE NETWORK EXPOSURE FUNCTION SERVICE INFORMATION
1010
TRANSMIT A MESSAGE TO AN AMF INDICATING A NEW EDGE NEF
1015
PROVIDE EDGE NEF SERVICES FOR END DEVICE AND MEC NETWORK
1020

Fig. 10

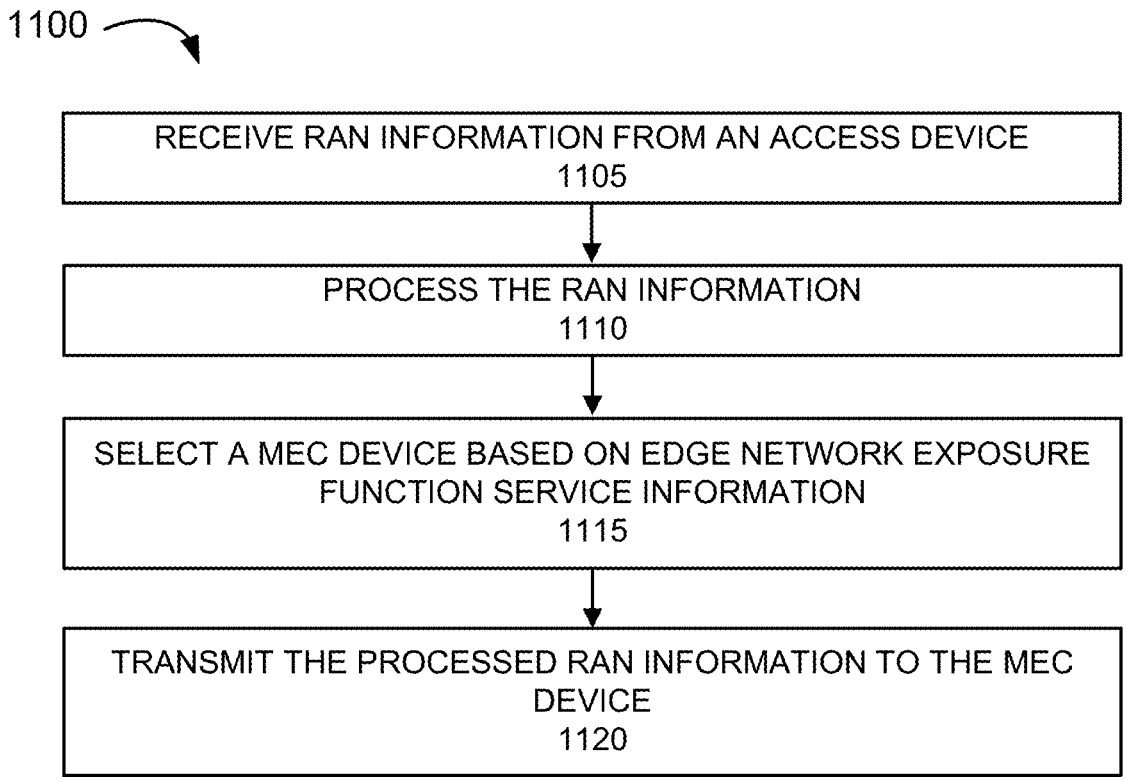
1100
RECEIVE RAN INFORMATION FROM AN ACCESS DEVICE
1105
PROCESS THE RAN INFORMATION
1110
SELECT A MEC DEVICE BASED ON EDGE NETWORK EXPOSURE FUNCTION SERVICE INFORMATION
1115
TRANSMIT THE PROCESSED RAN INFORMATION TO THE MEC DEVICE
1120

Fig. 11

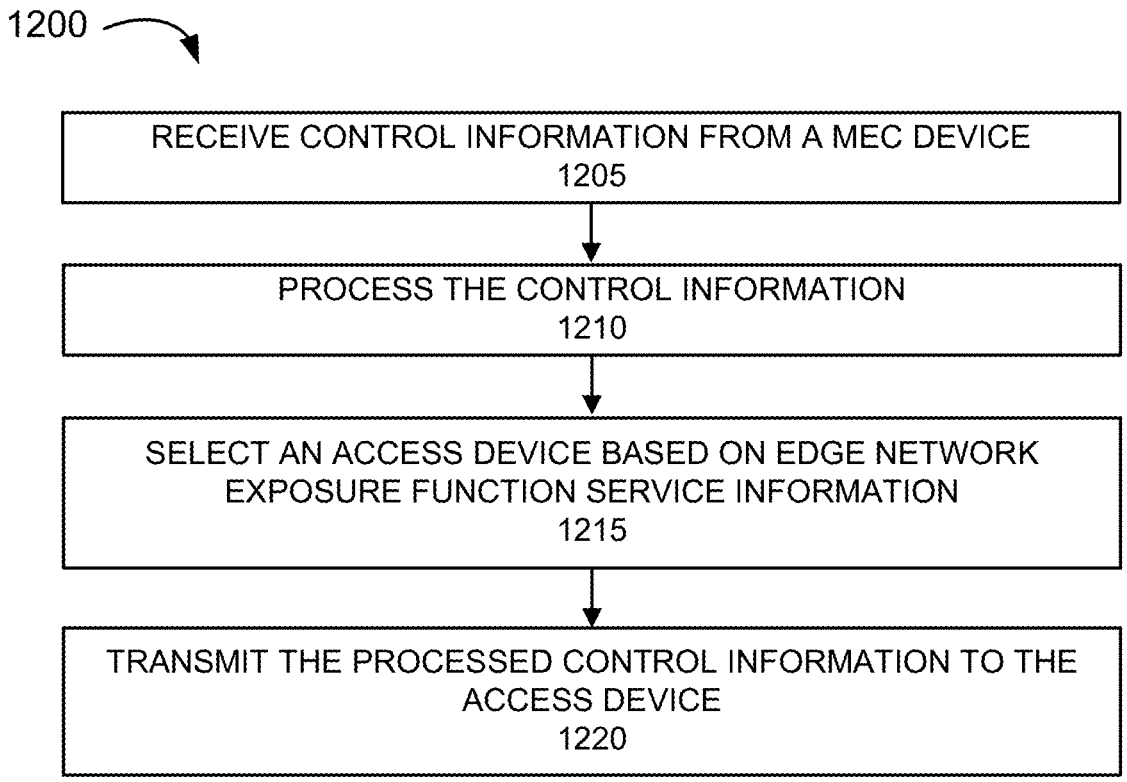
1200
RECEIVE CONTROL INFORMATION FROM A MEC DEVICE
1205
PROCESS THE CONTROL INFORMATION
1210
SELECT AN ACCESS DEVICE BASED ON EDGE NETWORK EXPOSURE FUNCTION SERVICE INFORMATION
1215
TRANSMIT THE PROCESSED CONTROL INFORMATION TO THE ACCESS DEVICE
1220

Fig. 12

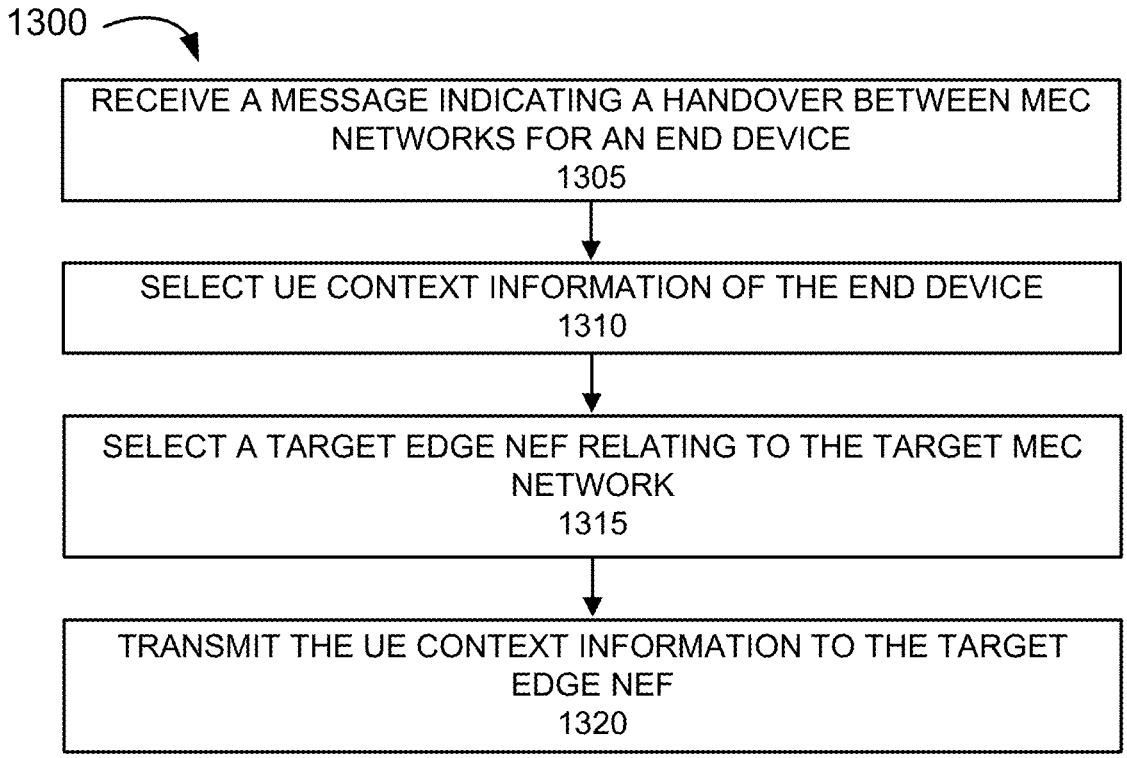
1300
RECEIVE A MESSAGE INDICATING A HANDOVER BETWEEN MEC NETWORKS FOR AN END DEVICE
1305
SELECT UE CONTEXT INFORMATION OF THE END DEVICE
1310
SELECT A TARGET EDGE NEF RELATING TO THE TARGET MEC NETWORK
1315
TRANSMIT THE UE CONTEXT INFORMATION TO THE TARGET EDGE NEF
1320

Fig. 13

METHOD AND SYSTEM FOR EDGE NETWORK EXPOSURE FUNCTION WITH MEC NETWORK

BACKGROUND

Development and design of networks present certain challenges from a network-side perspective and an end device perspective. In order to enhance performance, multi-access edge computing (MEC) (also known as mobile edge computing (MEC)) is being explored in which core network capabilities (e.g., computational, storage, communication links, etc.) are situated at the network edge in order to reduce traffic being sent to the core network and reduce latency amongst other things.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram illustrating an exemplary environment in which an exemplary embodiment of an edge network exposure function service may be implemented;

FIG. **2** is a diagram illustrating another exemplary environment in which an exemplary embodiment of the edge network exposure function service may be implemented;

FIG. **3**A is a diagram illustrating exemplary components of a main edge network exposure function that provides an exemplary embodiment of the edge network exposure function service;

FIG. **3**B is a diagram illustrating exemplary edge network exposure function service information;

FIG. **4**A is a diagram illustrating exemplary components of an edge network exposure function that provides an exemplary embodiment of the edge network exposure function service;

FIG. **4**B is a diagram illustrating exemplary edge network exposure function service information;

FIG. **5** is a diagram illustrating an exemplary process of an exemplary embodiment of the edge network exposure function service;

FIG. **6** is a diagram illustrating another exemplary process of an exemplary embodiment of the edge network exposure function service;

FIG. **7** is a diagram illustrating yet another exemplary process of an exemplary embodiment of the edge network exposure function service;

FIG. **8** is a diagram illustrating exemplary components of a device that may correspond to one or more of the devices illustrated and described herein;

FIG. **9** is a flow diagram illustrating an exemplary process of an exemplary embodiment of the edge network exposure function service;

FIG. **10** is a flow diagram illustrating another exemplary process of an exemplary embodiment of the edge network exposure function service;

FIG. **11** is a flow diagram illustrating still another exemplary process of an exemplary embodiment of the edge network exposure function service;

FIG. **12** is a flow diagram illustrating yet another exemplary process of an exemplary embodiment of the edge network exposure function service; and

FIG. **13** is a flow diagram illustrating another exemplary process of an exemplary embodiment of the edge network exposure function service.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The following detailed description refers to the accompanying drawings. The same reference numbers in different drawings may identify the same or similar elements. Also, the following detailed description does not limit the invention.

MEC networks or other types of end device application or service layer networks (also referred to as "application service layer network") provide an application and/or a service (also referred to as an "application service"). The application service may include a monolithic application, a microservice, or another type of configurable architecture of an application service. However, the architecture for MEC networks may operate as a closed environment and may not provide any orchestration among different MEC platforms or among MEC platforms and a macro network. This may be problematic when considering the interoperability between a multi-vendor environment and the MEC architecture. From a core network perspective, a Network Exposure Function (NEF) device (or other network device of the core network) may introduce latency in relation to the lifecycle and/or control of an application service of a MEC network.

There may be other limitations related to a MEC network. For example, a host in the MEC network, which may provide an application service, may be controlled by an entity of the MEC network and not by an entity associated with the application service. Also, an entity's network information (e.g., radio access network (RAN) information, operator's network internal information, network security information, etc.) may be exposed to the MEC network (e.g., from a RAN device) and may create various security and/or privacy risks or issues for the entity and/or their users. Further, the MEC network may offer limited MEC Application Programming Information (API) support. Additionally, the MEC network may require information from the rest of the network, e.g., when MEC customers move outside of the MEC footprint, which requires coordination and information exchange between network devices in the macro network and in the MEC network.

According to exemplary embodiments, an edge network exposure function (NEF) service is described. According to an exemplary embodiment, the edge network exposure function service includes network exposure functions, which may be situated at edge locations associated with MEC networks. For the sake of description and reference, these network exposure functions may be referred to as "edge network exposure functions."

According to an exemplary embodiment, the edge network exposure function service may also include a network exposure function that orchestrates the edge network exposure functions. For example, the network exposure function may operate as a centralized or controller-based network exposure function. The network exposure function may be situated in a core network. For the sake of description and reference, the network exposure function may be referred to as "main network exposure function."

According to an exemplary embodiment, the edge network exposure function may provide an edge network exposure function service. For example, the edge network exposure function may include an interface for a radio access network and an interface for a MEC network. The edge network exposure function may include logic that provides communication (e.g., the exchange of messages) between the radio access network and the MEC network. For example, the communication may include and/or pertain to RAN information (e.g., signal level, Quality of Service (QoS), radio frequency, signal level, etc.), MEC platform enablement, MEC application service management, bandwidth control, user equipment (UE) information, and UE Quality of Experience (QoE). The edge network exposure

function may include an API in support of communication and the edge network exposure function service.

According to an exemplary embodiment, the edge network exposure function may also include an interface that provides communication with one or multiple other edge network exposure functions. For example, the communication may include and/or pertain to UE location information, UE context information, and a handover procedure between MEC networks.

According to an exemplary embodiment, the edge network exposure function may include an interface that provides communication with the main network exposure function. For example, the communication may include and/or pertain to control services (e.g., traffic steering, QoS control, etc.), notification services (e.g., UE location changes, mobility, etc.), and platform and administrative services (e.g., add, delete, update an application service, etc.), as described herein.

According to an exemplary embodiment, the edge network exposure function may also include one or multiple other interfaces that provide communication with other network devices of the core network. For example, edge network exposure function may include an interface that provides communication with an Access and Mobility Management Function (AMF). For example, the communication may include and/or pertain to UE location and mobility.

According to an exemplary embodiment, the main network exposure function may include logic that manages and communicates with edge network exposure functions. Main network exposure function may also include logic that exposes services and capabilities and provides other functions in accordance with a standard (e.g., Third Generation Partnership Project (3GPP), International Telecommunication Union (ITU), European Telecommunications Standards Institute (ETSI), GSM Association (GSMA), etc.). The network exposure function may include an API in support of communication and the edge network exposure function service.

Although the edge network exposure function service may be described in relation to MEC networks, according to other exemplary embodiments, other types of application service layer networks may be implemented to include the edge network exposure function service.

In view of the foregoing, the edge network exposure function service may eliminate security and/or privacy vulnerabilities, facilitate handover between MEC networks, facilitate handover from/to MEC and macro networks, reduce latency issues relating to the provisioning and management of an application service, enhance MEC interoperability with a network, handle MEC service outages, and facilitate localized MEC control and operations.

FIG. **1** is a diagram illustrating an exemplary environment **100** in which an exemplary embodiment of the edge network exposure function service may be implemented. As illustrated, environment **100** includes access network **105**, MEC network **115-1** through **115-1+R** (also referred to collectively as MEC networks **115**, and individually or generally as MEC network **115**), and a core network **120**. Access network **105** includes access devices **107**. MEC network **115** includes MEC devices **117**. Core network **120** includes core devices **122**. Environment **100** further includes an edge network exposure function (NEF) and end devices **180**.

The number, type, and arrangement of networks illustrated in environment **100** are exemplary. For example, according to other exemplary embodiments, environment **100** may include an additional and/or different application service layer network that may or may not be subject to the edge network exposure function service. Additionally, or alternatively, other networks not illustrated in FIG. **1** may be included, such as a backhaul/fronthaul network or another type of network (e.g., an external network, etc.), as described herein.

The number, the type, and the arrangement of network devices, and the number of end devices **180** are exemplary. A network device, a network element, or a network function (also referred to as a network device) may be implemented according to one or multiple network architectures, such as a client device, a server device, a peer device, a proxy device, a cloud device, a virtualized network device. Additionally, a network device may be implemented according to various computing architectures, such as centralized, distributed, cloud (e.g., elastic, public, private, etc.), edge, fog, and/or another type of computing architecture, and may be incorporated into various types of network architectures (e.g., Software Defined Networking (SDN), virtual, logical, network slice, etc.).

Environment **100** includes communication links between the networks, between the network devices, and between end devices **180** and the network/network devices. Environment **100** may be implemented to include wired, optical, and/or wireless communication links. A communicative connection via a communication link may be direct or indirect. For example, an indirect communicative connection may involve an intermediary device and/or an intermediary network not illustrated in FIG. **1**. A direct communicative connection may not involve an intermediary device and/or an intermediary network. The number and the arrangement of communication links illustrated in environment **100** are exemplary.

Environment **100** may include various planes of communication including, for example, a control plane, a user plane, a service plane, and a network management plane. Environment **100** may include other types of planes of communication. A message communicated in support of the edge network exposure function service may use at least one of these planes of communication. Additionally, an interface of a network device may be modified (e.g., relative to an interface defined by a standard, such as 3GPP, ITU, ETSI, etc.) or a new interface of the network device may be provided in order to support the communication (e.g., transmission and reception of messages, information elements (IE), attribute value pairs (AVPs), etc.) between network devices that support the edge network exposure function service, as described herein. According to various exemplary implementations, the interface of a network device may be a service-based interface or a reference point-based interface.

Access network **105** may include one or multiple networks of one or multiple types and technologies. For example, access network **105** may be implemented to include a Fourth Generation (4G) radio access network (RAN) (e.g., an Evolved UMTS Terrestrial Radio Access Network (E-UTRAN) of a Long Term Evolution (LTE) network), a 4.5G RAN (e.g., an E-UTRAN of an LTE-Advanced (LTE-A) network), an RAN of an LTE-A Pro network, a next generation RAN (e.g., a Fifth Generation (5G)-access network (5G-AN) or a 5G-RAN (referred to herein as simply a 5G-RAN)), another type of future generation RAN, and/or another type of RAN (e.g., a legacy Third Generation (3G) RAN, etc.). Access network **105** may communicate with other types of access networks, such as, for example, a WiFi network, a Worldwide Interoperability for Microwave Access (WiMAX) network, a local area network (LAN), a Citizens Broadband Radio System

(CBRS) network, a cloud RAN, a wired network (e.g., optical, cable, etc.), an optical network, or another type of network that provides access to or can be used as an on-ramp to access network **105**, MEC network **115**, and/or core network **120**.

Access network **105** may include different and multiple functional splitting, such as options 1, 2, 3, 4, 5, 6, 7, or 8 that relate to combinations of access network **105** and core network **120** including an Evolved Packet Core (EPC) network and/or a NG core (NGC) network, or the splitting of the various layers (e.g., physical layer, Media Access Control (MAC) layer, Radio Link Control (RLC) layer, and Packet Data Convergence Control (PDCP) layer), plane splitting (e.g., user plane, control plane, etc.), centralized unit (CU) and distributed unit (DU), interface splitting (e.g., F1-U, F1-C, E1, Xn-C, Xn-U, X2-C, Common Public Radio Interface (CPRI), etc.) as well as other types of network services, such as dual connectivity (DC) or higher (e.g., a secondary cell group (SCG) split bearer service, a master cell group (MCG) split bearer, an SCG bearer service, non-standalone (NSA), standalone (SA), etc.), CA (e.g., intra-band, inter-band, contiguous, non-contiguous, etc.), network slicing, coordinated multipoint (CoMP), various duplex schemes (e.g., frequency division duplex (FDD), time division duplex (TDD), half-duplex FDD (H-FDD), etc.), and/or another type of connectivity service.

According to some exemplary embodiments, access network **105** may be implemented to include various architectures of wireless service, such as, for example, macrocell, microcell, femtocell, picocell, metrocell, new radio (NR) cell, LTE cell, non-cell, or another type of cell architecture. Additionally, according to various exemplary embodiments, access network **105** may be implemented according to various wireless technologies (e.g., radio access technologies (RATs), etc.), and various wireless standards, frequencies, bands, and segments of radio spectrum (e.g., centimeter (cm) wave, millimeter (mm) wave, below 6 Gigahertz (GHz), above 6 GHz, licensed radio spectrum, unlicensed radio spectrum, etc.), and/or other attributes or technologies used for radio communication.

Depending on the implementation, access network **105** may include one or multiple types of network devices, such as access devices **107**. For example, access devices **107** may include an evolved Node B (eNB), a next generation Node B (gNB), an evolved Long Term Evolution (eLTE) eNB, a radio network controller (RNC), a remote radio head (RRH), a baseband unit (BBU), a CU, a DU, a small cell node (e.g., a picocell device, a femtocell device, a microcell device, a home eNB, etc.), a future generation wireless access device, another type of wireless node (e.g., a WiFi device, a WiMax device, a hotspot device, etc.) that provides a wireless access service, or other another type of network device that provides a transport service (e.g., routing and forwarding), such as a router, a switch, or another type of layer **3** (e.g., network layer of the Open Systems Interconnection (OSI) model) network device. Additionally, or alternatively, access devices **107** may include wired and/or optical devices (e.g., modem, wired access point, optical access point, Ethernet device, etc.) that provide network access. According to some exemplary embodiments, access devices **107** may include an edge network exposure function that provides an edge network exposure function service, as described herein.

MEC network **115** includes a platform that provides an application service. As illustrated, MEC network **115** may be located at an edge of a network, such as access network **105**. Although not illustrated, MEC network may be co-located with another type of network, such as core network **120** or an external network. Alternatively, MEC network **115** may not be co-located. MEC network **115** may be implemented using one or multiple technologies including, for example, network function virtualization (NFV), containers, SDN, cloud computing, Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS), or another type of network technology.

Depending on the implementation, MEC network **115** may include various types of network devices that are illustrated in FIG. **1** as MEC devices **117**. For example, MEC devices **117** may include virtual network devices (e.g., virtualized network functions (VNFs), servers, hosts, containers, hypervisors, virtual machines, network function virtualization infrastructure (NFVI), and/or other types of virtualization elements, layers, hardware resources, operating systems, engines, etc.) and associated applications services for use by end devices **180**. The application services may pertain to broadband services in dense areas (e.g., pervasive video, smart office, operator cloud services, video/photo sharing, etc.), broadband access everywhere (e.g., 50/100 Mbps, ultra low-cost network, etc.), higher user mobility (e.g., high speed train, remote computing, moving hot spots, etc.), Internet of Things (IoTs) (e.g., smart wearables, sensors, mobile video surveillance, smart cities, connected home, etc.), extreme real-time communications (e.g., tactile Internet, augmented reality (AR), virtual reality (VR), etc.), lifeline communications (e.g., natural disaster, emergency response, etc.), ultra-reliable communications (e.g., automated traffic control and driving, collaborative robots, health-related services (e.g., monitoring, remote surgery, etc.), drone delivery, public safety, etc.), broadcast-like services, and/or other types of mobile edge application services.

Additionally, depending on the implementation, MEC devices **117** may include other types of network devices, such as an orchestrator (e.g., a network function virtualization orchestrator (NFVO), a mobile edge (ME) orchestrator, etc.), a virtualized infrastructure manager (VIM), a virtual network function manager (VNFM), an ME platform manager, an operations support system (OSS), a local domain name system (DNS), registries, a traffic rules controller, an ME platform, and/or other types of network devices (e.g., routers, core devices **122**, an ingress device, a load balancer, etc.), and network resources (e.g., storage devices, communication links, etc.).

Core network **120** may include one or multiple networks of one or multiple network types and technologies. Core network **120** may include a complementary network of access network **105**. For example, core network **120** may be implemented to include an Evolved Packet Core (EPC) of an LTE, an LTE-A, an LTE-A Pro, a next generation core (NGC) network, and/or a future generation core network. Core network **120** may include a legacy core network.

Depending on the implementation of core network **120**, core network **120** may include various types of network devices that are illustrated in FIG. **1** as core devices **122**. For example, core devices **122** may include a mobility management entity (MME), a packet gateway (PGW), a serving gateway (SGW), a home subscriber server (HSS), an authentication, authorization, and accounting (AAA) server, a policy charging and rules function (PCRF), a charging system (CS), a user plane function (UPF), an AMF, an SMF, a unified data management (UDM) device, an authentication server function (AUSF), a network slice selection function (NSSF), a network repository function (NRF), a network exposure function (NEF), a PCF, a network data analytics function (NWDAF), a lifecycle management (LCM) device,

and/or an application function (AF). According to other exemplary implementations, core network **120** may include additional, different, and/or fewer network devices than those described. For example, core devices **122** may include a non-standard and/or a proprietary network device, or another type of network device that may be well-known but not particularly mentioned herein.

Edge network exposure function **125** provides an edge network exposure function service, as described herein. Edge network exposure function **125** may include interfaces that provide communication with access network **105**, MEC network **115**, and core network **120**, as described herein. Edge network exposure function **125** is described further herein.

End device **180** includes a device that has computational and communication capabilities (e.g., wireless, wired, optical, etc.). End device **180** may be implemented as a mobile device, a portable device, a stationary device (e.g., a non-mobile device), a device operated by a user, or a device not operated by a user. For example, end device **180** may be implemented as a Mobile Broadband device, a smartphone, a computer, a tablet, a netbook, a phablet, a wearable device (e.g., a watch, glasses, a visor, etc.), a vehicle support system, an Internet of Things (IoT) device, a user device, an autonomous device, a smart device, a drone, customer premise equipment (e.g., a set top box, etc.), a streaming player device, a global positioning device, a game system, a music playing system, or some other type of wireless, wired, and/or optical end device. According to various exemplary embodiments, end device **180** may be configured to execute various types of software (e.g., applications, programs, etc.). The number and the types of software may vary among end devices **180**.

End device **180** may support one or multiple RATs (e.g., 4G, 5G, etc.) and various portions of the radio spectrum (e.g., multiple frequency bands, multiple carrier frequencies, licensed, unlicensed, etc.), network slicing, DC service, and/or other types of connectivity services. Additionally, end device **180** may include one or multiple communication interfaces that provide one or multiple (e.g., simultaneous) connections via the same or different RATs, frequency bands, carriers, network slices, and/or other communication medium (e.g., wired, etc.). The multimode capabilities of end device **180** may vary among end devices **180**.

FIG. **2** is a diagram illustrating a portion of an exemplary environment **200** in which an exemplary embodiment of the edge network exposure function service may be implemented. As illustrated, core network **120** includes core devices **122**, such as a main network exposure function **202** and an AMF **212**. Access network **105** includes access devices **107**, such as CU **210-1** and **210-2** (also referred to as CUs **210**, and individually or generally as CU **210**). Additionally, environment **200** includes edge network exposure functions **125-1** and **125-2** (also referred to collectively as edge network exposure functions **125**, and individually or generally as edge network exposure function **125**). As illustrated, according to some exemplary embodiments, a single edge network exposure function **125** may provide the network exposure function service to multiple MEC networks **115**. According to other exemplary embodiments, a dedicated edge network exposure function **125** may implemented for each MEC network **115**.

The number, type, and arrangement of network devices illustrated in environment **200** are exemplary. Additionally, the number, type, and arrangement of communication links illustrated in environment **200** are also exemplary.

According to an exemplary embodiment, edge network exposure function **125** may be communicatively coupled to a main network exposure function **202**. Edge network exposure function **125** may also be communicatively coupled to other types of core devices **122**, such as AMF **212**. Additionally, edge network exposure functions **125** may be communicatively coupled to access devices **107**, such as CUs **210**. According to other exemplary embodiments, edge network exposure function **125** may be communicatively coupled to a different type of access device **107**, such as an eNB, a gNB, an eLTE eNB, a BBU, or another type of access device **107** that may provide RAN information (e.g., a Radio Network Information Service (RNIS)), Wireless Local Area Network Information (e.g., WI Service (WIS)), or other types of wireless network information service.

As further illustrated, edge network exposure function **125** may be communicatively coupled to MEC devices **117**. For example, edge network exposure function **125** may be communicatively coupled to an ME management layer device (e.g., a VIM, a VNFM, an ME platform manager) and/or an ME host layer device (e.g., a ME platform, etc.). Additionally, edge network exposure functions **125** may be communicatively coupled to each other, as illustrated.

Main network exposure function **202** may be communicatively coupled to edge network exposure function **125**. Additionally, main network exposure function **202** may be communicatively coupled to MEC devices **117**. For example, according to an exemplary embodiment, the MEC devices **117** may include an orchestrator (e.g., an ME orchestrator, etc.). The orchestrator may manage and control multiple MEC networks **115**, for example. Main edge network exposure function **202** and edge network exposure function **125** are described further below.

FIG. **3**A is a diagram illustrating exemplary components of an exemplary embodiment of main network exposure function **202**. As illustrated, main network exposure function **202** may include an edge network exposure function interface **305**, a MEC interface **310**, edge network exposure function service information logic **315**, and a link **320**. According to other exemplary embodiments, main network exposure function **202** may include additional, fewer, and/or different components that support the edge network exposure function service, as described herein. Multiple components may be combined into a single component. Additionally, or alternatively, a single component may be implemented as multiple components in which a process or a function may be collaboratively performed or multiple processes or functions may be split between them. According to various embodiments, one or more of the components may operate on various planes of an environment. For example, the various planes may include a data plane, a control plane, a management plane, and/or other planes implemented within the environment.

As previously mentioned, main network exposure function **202** may also include interfaces and logic in accordance with a standard (e.g., 3GPP, ITU, etc.) and/or a proprietary nature associated with a network exposure function (e.g., of a 5G or future generation core network). However, for the sake of brevity, such interfaces and logic have been omitted from this description.

Edge network exposure function interface **305** may include an interface that provides communication with edge network exposure function **125** in support of the edge network edge function service. For purposes of description and reference, the interface is illustrated as an Nnef_edgenef interface.

MEC interface **310** may include an interface that provides communication with a MEC device **117**, such as an ME orchestrator **325** in support of the edge network exposure function service. For purposes of description and reference, the interface is illustrated as an Nnef_MEC interface.

Edge network exposure function service logic **315** may include logic that provides a MEC-edge network exposure function schema in support of the edge network exposure function service. For example, edge network exposure function service logic **315** may store edge network exposure function service information. FIG. **3**B is a diagram illustrating exemplary edge network exposure function service information that may be stored in a table **350**. As illustrated, table **350** may include a radio access network identifier field **355**, a MEC platform identifier field **360**, an edge network exposure function identifier field **365**, and an end device identifier field **370**. As further illustrated, table **350** includes records **375-1** through **375**-X (also referred to as records **375**, or individually or generally as record **375**) that each includes a grouping of fields **355** through **370** (e.g., correlated information). Edge network exposure function service information is illustrated in tabular form merely for the sake of description. In this regard, edge network exposure function service information may be implemented in a data structure different from a table.

Radio access network identifier field **355** may store an identifier of access device **107** from which RAN information is received by edge network exposure function **125**. Radio access network identifier field **355** may store an identifier of access device **107** that provides user plane data associated with an application service session between end device **180** and MEC network **115**. For example, in a plane-split architecture, radio access network identifier field **355** may store identifiers of a CU and a DU. According to other examples, in a non-plane-split architecture, the identifier may be of an eNB, a gNB, and so forth. Radio access network identifier field **355** may store other types of identifiers (e.g., a network slice identifier, a cell identifier, a sector identifier, etc.) and/or location information (e.g., tracking area code, tracking area identity, etc.) relating to access network **105** and end device **180**.

MEC platform identifier field **360** may store an identifier of MEC device **117**. For example, MEC platform identifier field **360** may store an identifier of a ME platform manager of MEC network **115**, an identifier of MEC network **115**, and/or an identifier of a ME platform or host device of MEC network **115**.

Edge network exposure function identifier field **365** may store an identifier of edge network exposure function **125**. End device identifier field **370** may store an identifier that identifies end device **180**. For example, the identifier may be an International Mobile Subscriber Identity (IMSI), a Subscription Concealed Identifier (SUPI), a Radio Network Temporary Identifier (RNTI), a Cell-RNTI (C-RNTI), or other type of identifier of end device **180**.

According to other exemplary implementations, table **350** may store additional, fewer, and/or different instances of edge network exposure function service information in support of the edge network exposure function service, as described herein. For example, the edge network exposure function service information may include other information pertaining to network topology, traffic profile information, information relating to an application service (e.g., type or category of application service, etc.), AMF identifiers, and/or other context information.

Referring back to FIG. **3**A, edge network exposure function service logic **315** may use the edge network exposure function service information to support various services. For example, edge network exposure function service logic **315** may provide a control service relating to traffic steering, QoS control, and/or bandwidth control. Edge network exposure function service logic **315** may generate messages, interpret messages received via edge network exposure function interface **305** and MEC interface **310**, and convert, filter, and/or translate messages in relation to the control service, and edge network exposure function **125** and/or MEC orchestrator **325** based on the edge network exposure function service information.

Edge network exposure function service logic **315** may provide a platform service that relates to an application service of MEC network **115**. For example, edge network exposure function service logic **315** may generate, interpret, convert, filter, and/or translate messages in relation to the platform service, and edge network exposure function **125** and/or MEC orchestrator **325**. By way of further example, the messages of the platform service may relate to adding, updating, deleting, instantiating, and/or other type of lifecycle aspect of an application service that may be associated with a MEC network **115** and MEC devices **117** (e.g., an ME platform manager, an ME platform and/or host device, etc.).

Edge network exposure function service logic **315** may provide a notification service. For example, edge network exposure function service logic **315** may generate messages, interpret, convert, filter, and/or translate messages in relation to the notification service, and edge network exposure function **125** and/or MEC orchestrator **325**. By way of further example, the messages of the notification service may relate to location changes of end device **180** and/or mobility information. Other examples may include notifications pertaining to congestion or other types of performance degradations in the network.

Link **320** provides a communicative link between two or more components in which data may be communicated. Link **320** may be implemented as a hardware link (e.g., a bus, a shared memory space, etc.), a software link (e.g., inter-process communication (IPC), etc.) or some other type of communicative link (e.g., API, etc.).

FIG. **4**A is a diagram illustrating exemplary components of an exemplary embodiment of edge network exposure function **125**. As illustrated, edge network exposure function **125** may include a NEF interface **405**, a MEC interface **410**, a MEC manager interface **415**, an AMF interface **420**, a RAN interface **425**, edge network exposure function service information logic **430**, and a link **435**. According to other exemplary embodiments, edge network exposure function **125** may include additional, fewer, and/or different components that support the edge network exposure function service, as described herein. Multiple components may be combined into a single component. Additionally, or alternatively, a single component may be implemented as multiple components in which a process or a function may be collaboratively performed or multiple processes or functions may be split between them. According to various embodiments, one or more of the components may operate on various planes of an environment. For example, the various planes may include a data plane, a control plane, a management plane, and/or other planes implemented within the environment.

Edge network exposure function **125** may also include interfaces and logic in accordance with a standard (e.g., 3GPP, ITU, etc.) and/or a proprietary nature associated with a network exposure function (e.g., of a 5G or future generation core network). However, for the sake of brevity, such interfaces and logic have been omitted from this description.

NEF interface **405** may include an interface that provides communication with network exposure function **202** in support of the edge network edge function service. For purposes of description and reference, the interface is illustrated as an Nedgenef_nef interface.

MEC interface **410** may include an interface that provides communication with a MEC device **117**, such as an ME platform **440** in support of the edge network exposure function service. For purposes of description and reference, the interface is illustrated as an Nedgenef_MEC interface.

MEC manager interface **415** may include an interface that provides communication with a MEC device **117**, such as an ME platform manager **445** in support of the edge network exposure function service. For purposes of description and reference, the interface is illustrated as an Nedgenef_MECm interface.

AMF interface **420** may include an interface that provides communication with a core device **122**, such as AMF **212** in support of the edge network exposure function service. For purposes of description and reference, the interface is illustrated as an Nedgenef_AMF interface. For example, edge network exposure function **125** may receive end device location, state, and/or status information relating to end device **180** from AMF **212**.

RAN interface **425** may include an interface that provides communication with an access device **107**, such as CU **210** in support of the edge network exposure function service. For purposes of description and reference, the interface is illustrated as an Nedgenef_ran interface. For example, edge network exposure function **125** may receive RAN information associated with an RNIS from access device **107**. The RAN information may relate to radio network conditions, measurement information related to the user plane, information about end device **180**, UE context and related radio bearers, and/or other radio network information that may be included in accordance with a standard (e.g., 3GPP) and/or of a proprietary nature. Edge network exposure function **125** may include a Radio Network Information (RNI) API that supports queries and subscriptions for RNI.

Edge NEF interface **427** may include an interface that provides communication with another edge network exposure function **125** in support of the edge network exposure function service. For purposes of description and reference, the interface is illustrated as an Nedgenef_edgenef interface. For example, edge network exposure function **125** may receive queries from another edge network exposure function **125**, and provide end device context information for handover purposes, and so forth.

Edge network exposure function service logic **430** may include logic that provides a MEC-edge network exposure function schema in support of the edge network exposure function service. For example, edge network exposure function service logic **430** may store edge network exposure function service information. FIG. **4**B is a diagram illustrating exemplary edge network exposure function service information that may be stored in a table **450**. As illustrated, table **450** may include a radio access network identifier field **455**, a MEC identifier field **460**, an end device identifier field **465**, and an application service field **470**. As further illustrated, table **450** includes records **475-1** through **475**-X (also referred to as records **475**, or individually or generally as record **475**) that each includes a grouping of fields **455** through **470** (e.g., correlated information). Edge network exposure function service information is illustrated in tabular form merely for the sake of description. In this regard, edge network exposure function service information may be implemented in a data structure different from a table.

Radio access network identifier field **455** may store an identifier of access device **107** from which RAN information is received by edge network exposure function **125**. Radio access network identifier field **455** may store an identifier of access device **107** that provides user plane data associated with an application service session between end device **180** and MEC network **115**. For example, in a plane-split architecture, radio access network identifier field **355** may store identifiers of a CU and a DU. According to other examples, in a non-plane-split architecture, the identifier may be of an eNB, a gNB, and so forth. Radio access network identifier field **455** may store other types of identifiers (e.g., a network slice identifier, a cell identifier, a sector identifier, etc.) and/or location information (e.g., tracking area code, tracking area identity, etc.) relating to access network **105** and end device **180**.

MEC platform identifier field **460** may store an identifier of MEC device **117**. For example, MEC platform identifier field **460** may store an identifier of a ME platform manager of MEC network **115**, an identifier of MEC network **115**, and/or an identifier of a ME platform or host device of MEC network **115**.

End device identifier field **465** may store an identifier that identifies end device **180**. For example, the identifier may be an IMSI, a SUPI, an RNTI, a C-RNTI, or other type of identifier of end device **180**.

Application service field **470** may store data relating to an application service associated with end device **180** and MEC network **115**. For example, application service field **470** may store the type or category of the application service.

According to other exemplary implementations, table **450** may store additional, fewer, and/or different instances of edge network exposure function service information in support of the edge network exposure function service, as described herein. For example, the edge network exposure function service information may include other information pertaining to network topology, traffic profile information, AMF identifiers, UE context information, UE profile information, and/or other context information.

Referring back to FIG. **4**A, edge network exposure function service logic **430** may use the edge network exposure function service information to support various services. For example, edge network exposure function service logic **430** may provide a control service relating to bandwidth control, end device information, end device QoE, RAN information, end device location information, and handover notification and procedure. Edge network exposure function service logic **430** may generate messages, interpret messages received via MEC interface **410** and RAN interface **425**, and convert, filter, and/or translate messages in relation to the control service, and access device **107** (e.g. CU **210**) and/or ME platform **440** based on the edge network exposure function service information.

Edge network exposure function service logic **430** may provide a platform service that relates to an application service of MEC network **115**. For example, edge network exposure function service logic **430** may generate, interpret, convert, filter, and/or translate messages in relation to the platform service, and ME platform manager **445** and/or access device **107**. By way of further example, the messages of the platform service may relate to adding, updating, deleting, instantiating, and/or other type of lifecycle or application service management aspect of an application service that may be associated with a MEC network **115** and MEC devices **117** (e.g., an ME platform manager, an ME platform and/or host device, etc.).

Edge network exposure function service logic **430** may provide a handover service. For example, edge network exposure function service logic **430** may query and transfer end device context information to a neighboring edge network exposure function **125** via edge NEF interface **427** when a handover occurs that impacts a MEC traffic flow. Additionally, edge NEF **125** may provide information to main NEF **202** to coordinate mobility between MEC network **115** and the macro network (e.g., access network **105**, core network **120**, etc.) including restricting services, which may only be applicable within the MEC network footprint.

Link **435** provides a communicative link between two or more components in which data may be communicated. Link **435** may be implemented as a hardware link (e.g., a bus, a shared memory space, etc.), a software link (e.g., inter-process communication (IPC), etc.) or some other type of communicative link (e.g., an application programming interface (API), etc.).

FIG. **5** is a diagram illustrating an exemplary process of an exemplary embodiment of the edge network exposure function service. The types of network devices are exemplary. For example, according to other exemplary processes, a different type of access device **107** (e.g., CU **210**) and/or a different type of MEC device **117** (e.g., ME Platform manager **445**) may be implemented. The messages described are exemplary, and the process may include additional or different messages.

Referring to FIG. **5**, according to an exemplary scenario, end device **180** may have initially attached to access network **105**, and transmits a request for an application service via access network **105**, and the request is received by CU **210**. According to another exemplary scenario, end device **180** may have an active application service session with MEC network **115**, but end device **180** has changed location (e.g., moved to a new cell, etc.). Based on the change of location, CU **210** may receive a message.

According to either exemplary scenario, in step (1), CU **210** may transmit a message (e.g., illustrated as a trigger event in FIG. **5**) to edge network exposure function **125**. In step (2), edge network exposure function **125** may receive the message via RAN interface **425**. Edge network exposure function **125** may interpret the message and determine that the message pertains to MEC orchestrator **325**. Edge network exposure function **125** may convert and generate the message for transmission to main network exposure function **202**. In step (3), edge network exposure function **125** may transmit the message to main network exposure function **202** via NEF interface **405**. In step (4), main network exposure function **202** may receive the message via edge NEF interface **305**, interpret the message, convert and generate a message for transmission to MEC orchestrator **325**. Main network exposure function **202** may transmit the message to MEC orchestrator **325** via MEC interface **310**.

In step (5), MEC orchestrator **325** may determine a MEC network **115** to provide an application service for end device **180**. MEC orchestrator **325** may initiate an enablement procedure that may create the application service at the appropriate MEC network **115** based on the locale of end device **180**. In step (6), MEC orchestrator **325** may generate and transmit a message (e.g., an enablement request as illustrated in FIG. **5**) to main network exposure function **202**. The enablement request may indicate a particular MEC network **115**.

In step (7), main network exposure function **202** may receive the message via MEC interface **310**. Main network exposure function **202** may interpret the message, convert and generate a message (e.g., enablement with various request parameters (req)). Main network exposure function **202** may use the edge network exposure function service information to select the edge network exposure function, and transmit the message to edge network exposure function **125** via edge NEF interface **305**. In step (8), edge network exposure function **125** may receive the message and interpret the message. Edge network exposure function **125** may select ME platform manager **445** of the particular MEC network **115** to transmit a message based on the edge network exposure function service information. Edge network exposure function **125** may convert and generate a message (e.g., enablement with various creation parameters (create)), and transmit the message to ME platform manager **445** via MEC manager interface **415**. In step (9), ME platform manager **445** may receive the message, and perform an enablement procedure. For example, ME platform manager **445** may cause ME platform **440** to create a virtual machine to provide the application service.

In steps (10) and (11), an acknowledgment or completion messages may be transmitted. In step (11), edge network exposure function **125** may update its edge network exposure function service information, and in step (12), main network exposure function **202** may also update its service information. In step (13), an acknowledgement or completion message may be transmitted to MEC orchestrator **325**. According to other exemplary embodiments, MEC orchestrator **325** may receive a trigger event message from an administrator device (not illustrated), as illustrated in step (4).

FIG. **6** is a diagram illustrating another exemplary process of an exemplary embodiment of the edge network exposure function service. The types of network devices are exemplary. For example, according to other exemplary processes, a different type of MEC device **117** (e.g., ME platform **440**) may be implemented. The messages described are exemplary, and the process may include additional or different types of messages. The process includes an administrative device **605**.

Referring to FIG. **6**, in step (1), administrative device **605** may transmit a message to MEC orchestrator **325**. The message may relate to upgrading software of MEC device **117** at MEC network **115**. According to this exemplary scenario, the upgrade of the software relates to a host device (e.g., ME platform **440**). In step (2), MEC orchestrator **325** may determine to which MEC device(s) **117** and MEC network(s) **115** the software upgrade pertains, and in step (3), transmit an upgrade message to main network exposure function **202**. The upgrade message may include the upgraded software. In step (4), main network exposure function **202** may receive the message via MEC interface **310** Main network exposure function **202** may store the software, coordinate staging for the software upgrade, and select appropriate edge network exposure function **125** to facilitate the software upgrade, for example. In steps (5)-(8), messages may be transmitted vie edge network exposure function **125** to set-up a software upgrade procedure, and in step (9), ME platform **440** may obtain and upgrade the software. In steps (10)-(13), for example, a message (e.g., an upgrade completion) may be transmitted to administration device **605**.

FIG. **7** is a diagram illustrating yet another exemplary process of an exemplary embodiment of the edge network exposure function service. The types of network devices are exemplary. For example, according to other exemplary processes, a different type of MEC device **117** (e.g., ME

platform **440**) may be implemented. The messages described are exemplary, and the process may include additional or different types of messages.

Referring to FIG. **7**, AMF **212** may transmit a message (e.g., trigger event) to main network exposure function **202**. The message may relate to a location of end device **180** (e.g., upon initial attachment) or a change of location (e.g., subsequent to attachment). Main network exposure function **202** may receive the message via AMF interface **420**. Main network exposure function **202** may select an appropriate edge network exposure function **125** based on the location of end device **180**. Main network exposure function **202** and MEC orchestrator **325** may exchange messages in relation to a change of location, as illustrated in step 2A.

In step (3), main network exposure function **202** may update the edge network exposure function service information based on the selection of the edge network exposure function **125**. In this way, information indicating the edge NEF, MEC, and end device association may be stored. In step (4), main network exposure function **202** may transmit a message that includes an identifier of AMF **212** and an identifier of end device **180**. In step (5), edge network exposure function **125** may update edge network exposure function service information based on the received message. In step (6), edge network exposure function **125** may transmit a message to AMF **212** indicating that edge network exposure function **125** relates to end device **180** and MEC network **115**. According to some exemplary embodiments, AMF **212** may transmit subsequent location updates to edge network exposure function **125** versus main network exposure function **202**.

FIG. **8** is a diagram illustrating exemplary components of a device **800** that may be included in one or more of the devices described herein. For example, device **800** may correspond to access device **107**, MEC device **117**, core device **122**, edge network exposure function **125**, end device **180**, main network exposure function **202**, CU **210**, ME orchestrator **325**, and/or other types of network devices, as described herein. As illustrated in FIG. **8**, device **800** includes a bus **805**, a processor **810**, a memory/storage **815** that stores software **820**, a communication interface **825**, an input **830**, and an output **835**. According to other embodiments, device **800** may include fewer components, additional components, different components, and/or a different arrangement of components than those illustrated in FIG. **10** and described herein.

Bus **805** includes a path that permits communication among the components of device **800**. For example, bus **805** may include a system bus, an address bus, a data bus, and/or a control bus. Bus **805** may also include bus drivers, bus arbiters, bus interfaces, clocks, and so forth.

Processor **810** includes one or multiple processors, microprocessors, data processors, co-processors, graphics processing units (GPUs), application specific integrated circuits (ASICs), controllers, programmable logic devices, chipsets, field-programmable gate arrays (FPGAs), application specific instruction-set processors (ASIPs), system-on-chips (SoCs), central processing units (CPUs) (e.g., one or multiple cores), microcontrollers, neural processing unit (NPUs), and/or some other type of component that interprets and/or executes instructions and/or data. Processor **810** may be implemented as hardware (e.g., a microprocessor, etc.), a combination of hardware and software (e.g., a SoC, an ASIC, etc.), may include one or multiple memories (e.g., cache, etc.), etc.

Processor **810** may control the overall operation or a portion of operation(s) performed by device **800**. Processor **810** may perform one or multiple operations based on an operating system and/or various applications or computer programs (e.g., software **820**). Processor **810** may access instructions from memory/storage **815**, from other components of device **800**, and/or from a source external to device **800** (e.g., a network, another device, etc.). Processor **810** may perform an operation and/or a process based on various techniques including, for example, multithreading, parallel processing, pipelining, interleaving, etc.

Memory/storage **815** includes one or multiple memories and/or one or multiple other types of storage mediums. For example, memory/storage **815** may include one or multiple types of memories, such as, a random access memory (RAM), a dynamic random access memory (DRAM), a static random access memory (SRAM), a cache, a read only memory (ROM), a programmable read only memory (PROM), an erasable PROM (EPROM), an electrically EPROM (EEPROM), a single in-line memory module (SIMM), a dual in-line memory module (DIMM), a flash memory (e.g., 2D, 3D, NOR, NAND, etc.), a solid state memory, and/or some other type of memory. Memory/storage **815** may include a hard disk (e.g., a magnetic disk, an optical disk, a magneto-optic disk, a solid state disk, etc.), a Micro-Electromechanical System (MEMS)-based storage medium, and/or a nanotechnology-based storage medium. Memory/storage **815** may include drives for reading from and writing to the storage medium.

Memory/storage **815** may be external to and/or removable from device **800**, such as, for example, a Universal Serial Bus (USB) memory stick, a dongle, a hard disk, mass storage, off-line storage, or some other type of storing medium (e.g., a compact disk (CD), a digital versatile disk (DVD), a Blu-Ray disk (BD), etc.). Memory/storage **815** may store data, software, and/or instructions related to the operation of device **800**.

Software **820** includes an application or a program that provides a function and/or a process. As an example, with reference to edge network exposure function **125** and main network exposure function **202**, software **820** may include an application that, when executed by processor **810**, provides a function of the edge network exposure function service, as described herein. Software **820** may also include firmware, middleware, microcode, hardware description language (HDL), and/or other form of instruction. Software **820** may also be virtualized. Software **820** may further include an operating system (OS) (e.g., Windows, Linux, Android, proprietary, etc.).

Communication interface **825** permits device **800** to communicate with other devices, networks, systems, and/or the like. Communication interface **825** includes one or multiple wireless interfaces and/or wired interfaces. For example, communication interface **825** may include one or multiple transmitters and receivers, or transceivers. Communication interface **825** may operate according to a protocol stack and a communication standard. Communication interface **825** may include an antenna. Communication interface **825** may include various processing logic or circuitry (e.g., multiplexing/de-multiplexing, filtering, amplifying, converting, error correction, application programming interface (API), etc.). Communication interface **825** may be implemented as a point-to-point interface, a service based interface, etc.

Input **830** permits an input into device **800**. For example, input **830** may include a keyboard, a mouse, a display, a touchscreen, a touchless screen, a button, a switch, an input port, speech recognition logic, and/or some other type of visual, auditory, tactile, etc., input component. Output **835** permits an output from device **800**. For example, output **835**

may include a speaker, a display, a touchscreen, a touchless screen, a light, an output port, and/or some other type of visual, auditory, tactile, etc., output component.

As previously described, a network device may be implemented according to various computing architectures (e.g., in a cloud, etc.) and according to various network architectures (e.g., a virtualized function, etc.). Device **800** may be implemented in the same manner. For example, device **800** may be instantiated, created, deleted, or some other operational state during its life-cycle (e.g., refreshed, paused, suspended, rebooting, or another type of state or status), using well-known virtualization technologies (e.g., hypervisor, container engine, virtual container, virtual machine, etc.) in a MEC network **115** or another type of application service layer network.

Device **800** may perform a process and/or a function, as described herein, in response to processor **810** executing software **820** stored by memory/storage **815**. By way of example, instructions may be read into memory/storage **815** from another memory/storage **815** (not shown) or read from another device (not shown) via communication interface **825**. The instructions stored by memory/storage **815** cause processor **810** to perform a process described herein. Alternatively, for example, according to other implementations, device **800** performs a process described herein based on the execution of hardware (processor **810**, etc.).

FIGS. **9-12** illustrate exemplary processes of exemplary embodiments of the edge network exposure function service. According to an exemplary embodiment, edge network exposure function **125** may perform steps of a process. According to an exemplary implementation, processor **810** executes software **820** to perform a step of a process, as described herein. Alternatively, a step may be performed by execution of only hardware.

FIG. **9** is a flow diagram illustrating an exemplary process **900** of an exemplary embodiment of the edge network exposure function service. In block **905**, edge network exposure function **125** may receive a request for an application service in relation to MEC network **115**. For example, the request may be received from main network exposure function via NEF interface **405**, which may be based on an enablement request from a MEC orchestrator. In block **910**, edge network exposure function **125** may select a MEC device **117** of MEC network **115** to transmit the request. For example, edge network exposure function **125** may select an ME platform manager of MEC network **115** based on the type of request. In block **915**, edge network exposure function **125** may generate and transmit a request to the selected MEC device **117**. Edge network exposure function **125** may convert the request message for MEC consumption. For example, the request message may be to instantiate (e.g., create) a VM that provides the application service at a host device of MEC network **115**. Edge network exposure function **125** may transmit the request message to MEC device **117** via MEC manager interface **415**. In block **920**, edge network exposure function **125** may store information that correlates edge network exposure function **125** with MEC **115** and end device **180**, as previously described. According to other exemplary embodiments, the request may pertain to other lifecycle aspects of an application service (e.g., delete, suspend, etc.).

FIG. **10** is a flow diagram illustrating another exemplary process **1000** of another exemplary embodiment of the edge network exposure function service. In block **1005**, edge network exposure function **125** may receive a message via NEF interface **405** from main network exposure function **202**. For example, the message may include an end device identifier, an AMF identifier, and a MEC identifier. In block **1010**, edge network exposure function **125** may update edge network exposure function service information based on the message. In block **1015**, edge network exposure function may generate and transmit a message to AMF **212** associated with the AMF identifier via AMF interface **420**. The message may indicate that edge network exposure function **125** is assigned to end device **180** associated with the end device identifier. In block **1020**, edge network exposure function **125** may provide the edge network exposure function service for end device **180** and associated MEC network **115**.

FIG. **11** is a flow diagram illustrating still another exemplary process **1100** of another exemplary embodiment of the edge network exposure function service. In block **1105**, edge network exposure function **125** may receive RAN information from access device **107** via RAN interface **425**. For example, the RAN information may be associated with a RNIS. In block **1110**, edge network exposure function **125** may process the RAN information. For example, edge network exposure function **125** may convert and/or aggregate the RAN information for consumption by MEC device **117** and/or filter the RAN information to prevent security exposure of certain RAN information. By way of further example, edge network exposure function **125** may remove one or more instances of the RAN information.

In block **1115**, edge network exposure function **125** may select MEC device **117** to transmit the RAN information based on the edge network exposure function service information. In block **1120**, edge network exposure function **125** may generate and transmit the RAN information to the selected MEC device **117** via MEC interface **410** or MEC manager interface **415**. According to other exemplary embodiments, information different from the RAN information may be received and transmitted to MEC device **117**, such as a UE profile, etc.

FIG. **12** is a flow diagram illustrating yet another exemplary process **1200** of another exemplary embodiment of the edge network exposure function service. In block **1205**, edge network exposure function **125** may receive control information from MEC device **117** via MEC interface **410**. For example, the control information may relate to bandwidth control, QoS parameters associated with a traffic flow, traffic shaping, a network slice, and/or another type of application service management information. In block **1210**, edge network exposure function **125** may process the control information. For example, edge network exposure function **125** may convert the control information for consumption by access device **107**. In block **1215**, edge network exposure function **125** may select access device **107** to transmit the control information based on the edge network exposure function service information. In block **1220**, edge network exposure function **125** may generate and transmit the control information to the selected access device **107** via RAN interface **425**. According to other exemplary embodiments, information different from the control information may be received and transmitted to access device **107**.

FIG. **13** is a flow diagram illustrating another exemplary process **1300** of another exemplary embodiment of the edge network exposure function service. In block **1305**, edge network exposure function **125** may receive a message indicating a handover between MEC networks **115** and end device **180** via NEF interface **405**. In block **1310**, edge network exposure function **125** may interpret the message and select UE context information pertaining to end device **180**. In block **1315**, edge network exposure function **125** may select a target edge network exposure function **125** relating to the target MEC network associated with the

handover to transmit the UE context information. For example, edge network exposure function **125** may store and perform a lookup of topology information and/or the received message may include an identifier of the target network exposure function **125**. In block **1320**, edge network exposure function **125** may generate and transmit the UE context information to the selected edge network exposure function **125** via edge NEF interface **427**. According to other exemplary embodiments, information different from the UE context information may be transmitted to the target edge network exposure function **125**.

As set forth in this description and illustrated by the drawings, reference is made to "an exemplary embodiment," "an embodiment," "embodiments," etc., which may include a particular feature, structure or characteristic in connection with an embodiment(s). However, the use of the phrase or term "an embodiment," "embodiments," etc., in various places in the specification does not necessarily refer to all embodiments described, nor does it necessarily refer to the same embodiment, nor are separate or alternative embodiments necessarily mutually exclusive of other embodiment (s). The same applies to the term "implementation," "implementations," etc.

The foregoing description of embodiments provides illustration, but is not intended to be exhaustive or to limit the embodiments to the precise form disclosed. Accordingly, modifications to the embodiments described herein may be possible. For example, various modifications and changes may be made thereto, and additional embodiments may be implemented, without departing from the broader scope of the invention as set forth in the claims that follow. The description and drawings are accordingly to be regarded as illustrative rather than restrictive.

The terms "a," "an," and "the" are intended to be interpreted to include one or more items. Further, the phrase "based on" is intended to be interpreted as "based, at least in part, on," unless explicitly stated otherwise. The term "and/or" is intended to be interpreted to include any and all combinations of one or more of the associated items. The word "exemplary" is used herein to mean "serving as an example." Any embodiment or implementation described as "exemplary" is not necessarily to be construed as preferred or advantageous over other embodiments or implementations.

In addition, while series of blocks have been described with regard to the processes illustrated in FIGS. **9-13**, the order of the blocks may be modified according to other embodiments. Further, non-dependent blocks may be performed in parallel. Additionally, other processes described in this description may be modified and/or non-dependent operations may be performed in parallel.

Embodiments described herein may be implemented in many different forms of software executed by hardware. For example, a process or a function may be implemented as "logic," a "component," or an "element." The logic, the component, or the element, may include, for example, hardware (e.g., processor **810**, etc.), or a combination of hardware and software (e.g., software **820**).

Embodiments have been described without reference to the specific software code because the software code can be designed to implement the embodiments based on the description herein and commercially available software design environments and/or languages. For example, various types of programming languages including, for example, a compiled language, an interpreted language, a declarative language, or a procedural language may be implemented.

Use of ordinal terms such as "first," "second," "third," etc., in the claims to modify a claim element does not by itself connote any priority, precedence, or order of one claim element over another, the temporal order in which acts of a method are performed, the temporal order in which instructions executed by a device are performed, etc., but are used merely as labels to distinguish one claim element having a certain name from another element having a same name (but for use of the ordinal term) to distinguish the claim elements.

Additionally, embodiments described herein may be implemented as a non-transitory computer-readable storage medium that stores data and/or information, such as instructions, program code, a data structure, a program module, an application, a script, or other known or conventional form suitable for use in a computing environment. The program code, instructions, application, etc., is readable and executable by a processor (e.g., processor **810**) of a device. A non-transitory storage medium includes one or more of the storage mediums described in relation to memory/storage **815**. The non-transitory computer-readable storage medium may be implemented in a centralized, distributed, or logical division that may include a single physical memory device or multiple physical memory devices spread across one or multiple network devices.

To the extent the aforementioned embodiments collect, store or employ personal information of individuals, it should be understood that such information shall be collected, stored, and used in accordance with all applicable laws concerning protection of personal information. Additionally, the collection, storage and use of such information can be subject to consent of the individual to such activity, for example, through well known "opt-in" or "opt-out" processes as can be appropriate for the situation and type of information. Collection, storage and use of personal information can be in an appropriately secure manner reflective of the type of information, for example, through various encryption and anonymization techniques for particularly sensitive information.

No element, act, or instruction set forth in this description should be construed as critical or essential to the embodiments described herein unless explicitly indicated as such.

All structural and functional equivalents to the elements of the various aspects set forth in this disclosure that are known or later come to be known are expressly incorporated herein by reference and are intended to be encompassed by the claims.

What is claimed is:

1. A method comprising:

storing, by an edge network exposure function device, service information that includes correlations between portions of a radio access network and application service layer networks;

receiving, by the edge network exposure function device from a radio access network device, radio access network information associated with one of the portions of the radio access network;

converting, by the edge network exposure function device, the radio access network information including removing one or more instances of the radio access network information relating to at least one of privacy or security of a network operator;

selecting, by the edge network exposure function device, a first application service layer network device of one of the application service layer networks based on the service information; and

transmitting, by the edge network exposure function device to the first application service layer network device, the converted radio access network information.

2. The method of claim 1, wherein the service information further includes correlations with network topology and traffic profile information, and wherein the one or more instances of the radio access network information include proprietary information that relates to privacy and security of the network operator.

3. The method of claim 1, wherein the one of the application service layer networks is a multi-access edge computing (MEC) network.

4. The method of claim 1, wherein the first application service layer network device includes a multi-access edge platform manager.

5. The method of claim 1, further comprising:

storing, by the edge network exposure function device, end device context information pertaining to an end device and an application service session associated with the one of the application service layer networks;

receiving, by the edge network exposure function device from a main network exposure function device, a message indicating a handover for the end device to another one of the application service layer networks; and

transmitting, by the edge network exposure function device to another edge network exposure function device associated with the other one of the application service layer networks, the end device context information.

6. The method of claim 1, further comprising:

receiving, by the edge network exposure function device from a second application service layer network device of the one of the application service layer networks, control information pertaining to an end device and an application service session associated with the one of the application service layer networks;

converting, by the edge network exposure function device, the control information;

selecting, by the edge network exposure function device, the radio access network device based on the service information and the control information; and

transmitting, by the edge network exposure function device to the radio access network device, the converted control information.

7. The method of claim 1, further comprising:

receiving, by the edge network exposure function device from a main network exposure function device, a message that pertains to a lifecycle of an application service provided by the one of the application service layer networks;

selecting, by the edge network exposure function device, a second application service layer network device of the one of the application service layer networks based on the service information and the message; and

transmitting, by the edge network exposure function device to the second application service layer network device, the message.

8. The method of claim 7, wherein the message indicates to instantiate the application service.

9. An edge network exposure function device comprising:

a communication interface;

a processor, wherein the processor is configured to:

store service information that includes correlations between portions of a radio access network and application service layer networks;

receive, via the communication interface from a radio access network device, radio access network information associated with one of the portions of the radio access network;

convert the radio access network information including removing one or more instances of the radio access network information relating to at least one of privacy or security of a network operator;

select a first application service layer network device of one of the application service layer networks based on the service information; and

transmit, via the communication interface to the first application service layer network device, the converted radio access network information.

10. The edge network exposure function device of claim 9, wherein the service information further includes correlations with network topology and traffic profile information, and wherein the one or more instances of the radio access network information include proprietary information that relates to privacy and security of the network operator.

11. The edge network exposure function device of claim 9, wherein the one of the application service layer networks is a multi-access edge computing (MEC) network.

12. The edge network exposure function device of claim 9, wherein the first application service layer network device includes a multi-access edge platform manager.

13. The edge network exposure function device of claim 9, wherein the processor is further configured to:

store end device context information pertaining to an end device and an application service session associated with the one of the application service layer networks;

receive, via the communication interface from a main network exposure function device, a message indicating a handover for the end device to another one of the application service layer networks; and

transmit, via the communication interface to another edge network exposure function device associated with the other one of the application service layer networks, the end device context information.

14. The edge network exposure function device of claim 9, wherein the processor is further configured to:

receive, via the communication interface from a second application service layer network device of the one of the application service layer networks, control information pertaining to an end device and an application service session associated with the one of the application service layer networks;

convert the control information;

select the radio access network device based on the service information and the control information; and

transmit, via the communication interface to the radio access network device, the converted control information.

15. The edge network exposure function device of claim 14, the processor is further configured to:

receive, via the communication interface from a main network exposure function device, a message that pertains to a lifecycle of an application service provided by the one of the application service layer networks;

select a second application service layer network device of the one of the application service layer networks based on the service information and the message; and

transmit, via the communication interface to the second application service layer network device, the message.

16. The edge network exposure function device of claim 15, wherein the message indicates to instantiate the application service.

17. A non-transitory computer-readable storage medium storing instructions executable by a processor of an edge network exposure function device, which when executed cause the edge network exposure function device to:

store service information that includes correlations between portions of a radio access network and application service layer networks;

receive, from a radio access network device, radio access network information associated with one of the portions of the radio access network;

convert the radio access network information including removing one or more instances of the radio access network information relating to at least one of privacy or security of a network operator;

select a first application service layer network device of one of the application service layer networks based on the service information; and

transmit, to the first application service layer network device, the converted radio access network information.

18. The non-transitory computer-readable storage medium of claim 17, wherein the service information further includes correlations with network topology and traffic profile information, and wherein the one or more instances of the radio access network information include proprietary information that relates to privacy and security of the network operator.

19. The non-transitory computer-readable storage medium of claim 17, wherein the instructions further comprise instructions, which when executed by the processor further cause the edge network exposure function device to:

store end device context information pertaining to an end device and an application service session associated with the one of the application service layer networks;

receive, from a main network exposure function device, a message indicating a handover for the end device to another one of the application service layer networks; and

transmit, to another edge network exposure function device associated with the other one of the application service layer networks, the end device context information.

20. The non-transitory computer-readable storage medium of claim 17, wherein the one of the application service layer networks is a multi-access edge computing (MEC) network, and wherein the first application service layer network device includes a multi-access edge platform manager.

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